SKF Online Motor Analysis System
NetEP/iNetEP

User Manual Part No. 71-055-EN

User Manual

⚠ ***Please read and thoroughly understand the contents of this entire guide before performing any installation of this product. Failure to follow the instructions and safety precautions in this manual can result in serious injury, damage to the product, damage to other equipment, or a malfunctioning system. Keep this guide in a safe and ready location for future reference.***

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Intended use of instrument

The NetEP is intended for the monitoring of electric motors and machines for the purpose of detecting and reporting early indications of motor and machine faults. It is not intended to be a control nor safety system.

Note on Software

While the NetEP is a Microsoft Windows® based instrument, it is specially configured and optimized to perform the functions for which it was designed. The loading or operation of unauthorized software may cause the instrument to malfunction or cease functioning and may void the manufacturer's warranty.

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NetEP - test equipment and desktop versions.

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The NETEP contains computer software that is vulnerable to damage from computer viruses. Before shipping, Baker/SKF scanned all data to ensure the NETEP is virus-free. Before inserting any disks into the disk drive or connecting the NETEP to a computer network, scan all disks for viruses.

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Preface

Important safety information

General Safety Precautions

Note: The general safety information presented here is for both operating and service personnel. Specific warnings and cautions will be found throughout this manual where they apply.

Note: If the equipment is used in any manner not specified by Baker Instrument Company, an SKF Group Company, the safety protection provided by the equipment may be impaired.

Safety term definition

DANGER: Indicates a hazardous situation, which, if not avoided, will result in death or serious injury.

WARNING: Indicates a hazardous situation, which, if not avoided, could result in death or serious injury.

CAUTION: Indicates a hazardous situation, which, if not avoided, could result in minor or moderate injury.

NOTICE: This signal word addresses practices that could result in property damage but not personal injury.

Symbols/Labels on equipment

	Voltage level warning. 1000 V Maximum input

Other Important Safety Warnings

1) **Warning:** Do not operate the instrument with front door open. When the instrument door is open, the instrument is not water resistant and should not be operated. Do not allow the opened instrument to be exposed to water. Water in contact with the interior of the instrument compromises protection features and could result in serious injury or death.

2) **Warning**: Because of the voltages present, testing should be conducted only by trained personnel, and adequate safety precautions must be followed to minimize the risk of serious injury, death, or property damage.

3) **Warning**: Because of the dangerous currents, voltages, and forces encountered when operating, testing or repairing rotating equipment, safety precautions must be taken for all tests. Follow all safety precautions in this manual and required by your employer. Due to the wide diversity of machine applications, it is impossible to list all general safety precautions. However, this manual includes special safety precautions applicable to the use of the NetEP.

4) **NOTICE** The maximum rating of the NetEP is 1000 V. Under no circumstances connect the voltage sensing circuit to higher voltage levels. Doing so will cause severe damage to instrument.

Operational safety warnings

Baker Instrument Company, an SKF Group Company, recommends that the operator comply with the following safety precautions:

1) Comply with all your facility's safety practices at all times.
2) Ensure physical setup does not interfere with your facility's current or intended operation.

Additionally, these safety precautions must be followed, otherwise dangerous shock hazards may exist:

1) Use whatever safety equipment required by your organization including eye protection, high voltage gloves, arc-flash rated masks, hoods and any required PPC. Prior to opening any MCC (Motor Control Cabinet), ensure that appropriate arc-flash protection clothing is worn.
2) Ensure that appropriate lockout / tag-out procedures are properly understood and implemented by all personnel.
3) Do not touch the connections, PT's, CT's or any component under test while a test is being made.
4) This product is grounded through the grounding conductor of the power input.
5) During repairs, do not substitute any parts. Use only factory-supplied parts.
6) This instrument is **NOT** approved for use in an explosive environment.

CE Declaration of conformity

To be supplied by Intertek based on their testing

2004/108/EC for EMC
EN61326 for equipment type

Additional regulatory information

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in its installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the product manual, may cause harmful interference to radio communications. If this equipment does cause harmful interference, the user will be required to correct the interference.

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1
System description

System Description

The SKF Online Motor Analysis System NetEP is an Ethernet connected electric motor monitoring system. It is a permanently mounted system, capable of monitoring up to 32 motors on seven different voltage busses. The system gathers data from the voltages and currents flowing to the motor. This data is used to determine key performance levels as well as to generate spectral measurements. Several alarms levels can be set to identify measurements that are out of range and alert the user.

Being a network connected system, the measurements, alarms and configuration can be viewed using the provided desktop software from any computer connected to the network. Authorized users can also modify the monitoring configuration from the desktop software. The NetEP runs continuously, thus motors can be monitored 24 hours a day, 7 days a week.

The system provides an at a glance summary displays that show the overall status of all monitored machines. This is provided even across multiple NetEP's at multiple locations, making remote monitoring of all motors from any location possible.

A central data server, running Microsoft SQL Server or Microsoft SQL Express, collects data from the unit. The server software also runs on the central data server, and is capable of collecting data from multiple NetEP's. This allows data viewing from multiple motors, factories, NetEP's at one time through the desktop software.

Hardware overview

The system connects to 3 measurement CT's (current transformers) per motor. The CT's should be within 150 feet of the NetEP unit. CT signals are run on standard CAT V networking cable for easy installation and cable routing. CT's come in four current ratings, 5 A, 50 A, 200 A and 600 A. The CT's are available in either solid core or split core configurations. For best performance, actual steady state motor currents should be between 10% and 90% of the CT current rating. CT performance must be calibrated for accurate measurements. Using the optional NetEP calibration kit, the CT's can be calibrated at the installation site. CT calibration is also available as a service from Baker/SKF.

The unit requires 110 V – 240 V 50/60 Hz power for its internal measurement circuitry and computer. A standard wired LAN connection is also required.

> **NOTICE**: Voltage Busses up to 1,000 V can be connected to the system. It is strongly recommended that external safety disconnects be provided for each voltage buss connected to the NetEP. **To avoid potential hazards voltage busses must be de-engergized before opening the NetEP door.** The NetEP does not have any internal disconnect mechanism for the Voltage Busses being measured.

Software overview

> **NOTICE**
> - There are no user serviceable parts in the NetEP. The system includes a built in self test capability.
> - If the built in self test fails, or there is a suspected hardware failure in the system, please contact Baker/SKF service.

The NetEP

system consists of three software programs; the device software, the server software and the desktop software (SKF Motor Analysis Surveyor).

The device software is the embedded software running on the computer in the system box. It is responsible for the scheduling and acquisition of data from the hardware, and for communicating that data to the server software via the wired LAN connection. The device software requires little or no user input after the initial installation and configuration of the NetEP system. During installation, the hardware calibration and verification of connections to the CT's and Voltage Busses are done using the device software. This requires that a monitor and keyboard be connected to the NetEP device during installation.

To view data, alarms, trends and spectra, the SKF Motor Analysis Surveyor software is used. This software runs on a Windows® based system, and a network connection is required. The Surveyor software is the primary system interface. All motor, measurement and alarm limits are set here. The Surveyor software contains several different views suitable for detailed configuration of the unit as well as at a glance machine status. It also includes detailed data analysis displays. The Surveyor software retrieves data from the server software to populate its displays and to perform analysis.

The server software manages the communication and data storage for the NetEP's connected to it. The server software should run on a moderate to high performance Windows® workstation, with good network connectivity, and preferably UPS power. Microsoft® SQL Server or SQL Express is required for data storage by the server software. Like the device software, the desktop software also accesses the server software. Some configuration is required through the server software interface. The server hardware, software and database are also available as a service from Baker/SKF.

The NetEP software configuration from the factory is such that the device software will automatically find and connect to the server software, provided they are on the same subnet. Surveyor software requires configuration with the IP address of the server software to allow connection. The NetEP system administrator can assign different levels of capability (ie: view only, edit etc) to each user of the system.

Network configuration

The system software program uses Standard Ethernet configurations and protocols.
Factory default networking settings (changeable by system administrator).

- NetEP device software: TCP/IP protocol using port 1100, or UDP on port 1150. IP Address DHCP.
- NetEP server software: TCP/IP protocol using port 1100, or UDP on port 1150. A static IP Address is recommended.
- SKF Motor Analysis Surveyor: TCP/IP protocol using port 1100 or UDP on port 1150. IP Address DHCP.

Configuration of the three software programs is simplified if the Device, Server and Surveyor are on the same subnet. If they are not, configuration of firewalls to allow connection and communication between the software programs is required. Without this connectivity, software will not operate correctly.

2
Software Configuration

See Appendix A for reference material on installing MS SQL Server and MS SQL Express. In order to set up the NetEP server installation, MS SQL Server or MS SQL Express must be operational on the computer.

SKF Online Motor Analysis System - NetEP server installation

The NetEP server software provides for the storage of data from the NetEP. The NetEP server also is the communication link between the desktop client and the NetEP. As such, the computer running the NetEP software has the following requirements:

- Greater than2 GHz Pentium, Core2 Duo or equivalent
- Greater than2 GB RAM
- Greater than 10 GB free disc space per NetEP connected
- Windows XP, Vista, 7 or Server 2003
- 10/100 LAN connection
- Microsoft SQL or SQL Express
- Static IP Address
- UPS recommended

The computer running the NetEP Server software must be continuously operational. If this computer is off for more than 30 minutes, the NetEP device may run out of storage space and; therefore, discard data. If this guaranteed operation is unfeasible, there is a NetEP Server Service available from Baker/SKF that meets this requirement. This server service is greater than 99.9 percent availability. Also note, when the computer running the NetEP server software is unavailable, the SKF Motor Condition Surveyor software will not be able to view NetEP device data, nor be able to change any device settings.

The first step for the installation of the NetEP Server software is to install the database to be used. This database can be either Microsoft SQL or Microsoft SQL Express. Knowledge of the path to the database is required during the installation of the NetEP server software.

Installation procedure

1) To install the NetEP server software, locate the NetEP server CD, and insert it into the computer CD drive.
2) When prompted, provide the path to the storage database to be used to house the motor data gathered by the NetEP.
3) Once the NetEP server software has loaded, if appropriate change the name of the NetEP server, set the number of NetEP devices that can connect to this server, and change the Port used to communicate with the NetEP Device.

Suggested network topology

The graphic below shows the suggested network topology for the NetEP devices and NetEP Server, the ports required for operation, and the expected data rates. Consult your organization's IT group to properly set up the network.

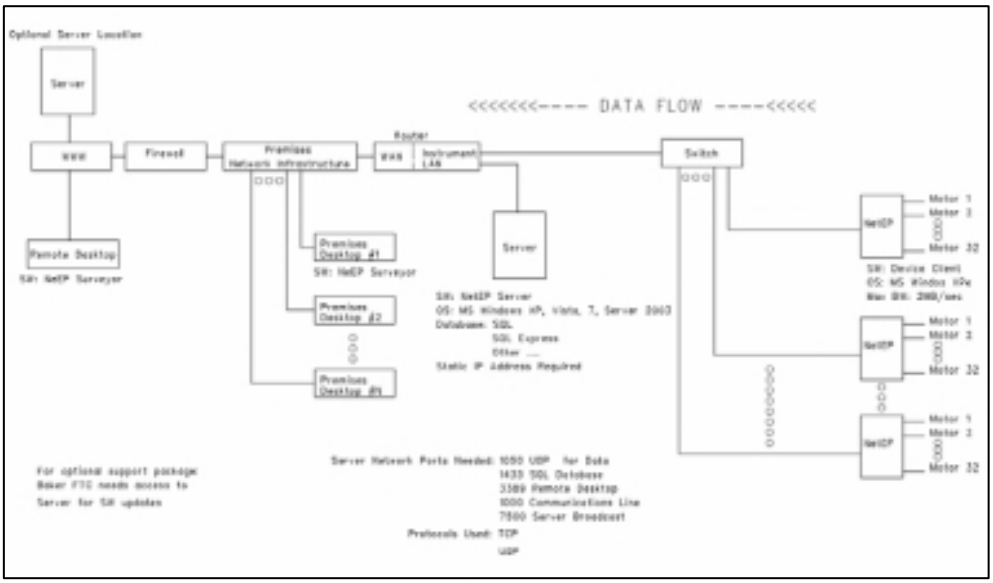


Fig 2-1: Network topology diagram

Configure your Server

1) Go to Start->Run->Surveyor and Launch the Surveyor Application.
2) If the software is not activated it will ask you to activate your software.
3) Go to Tools->NetEP Server and click **Settings**.
    i. This option is only available if you are logged on to Windows as an Administrator, or for Vista/7 the software is being run in administrator mode.
4) Select the Servers tab.
5) Click **Add** to create a new server.
6) Give your server a name (or use the default name).
7) Set the TCP port that your server will use to communicate with your NetEP(s).
    i. This port must be unblocked (for TCP) on any firewalls or routers that are in-between the NetEP and your server.
8) If you want your NetEP(s) to automatically detect and configure their own network settings place a check in Broadcase Connection Information, select a port to broadcast on and a time interval to do the broadcast.
    i. This port must be unblocked (for UDP) on any firewalls that are in-between the NetEp and your server.
    ii. This setting will only work if the NetEp(s) exist on the same subnet. If your NetEp(s) are not on the same subnet you should uncheck this box, and you will need to manually configure them.
9) Configure the database server settings for your remote client (NetEp)
10) These are the settings the NetEp will use to connect to your database.
11) If your server require different setting to connect to the database configure them in the **Local Database Server Settings**, otherwise leave it set to **Same as Remote.**

12) Click **Browse** and select the database that you would like this server to use.

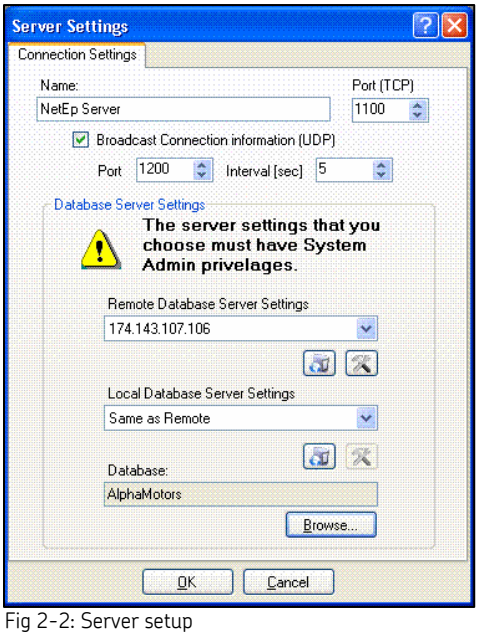


Fig 2-2: Server setup

NetEP Device Software is factory installed on the instrument. No changes in the configuration are

required, except the entry of the NetEP Server IP address if the broadcast beacon is disabled and the Server is on a different subnet than the NetEP Device. Upgrades and new revisions of NetEP device software are included in the NetEP server software, and automatically install on the NetEP device when the NetEP Server software is updated. Should the NetEP device become corrupted and need reloading, please contact Baker/SKF for assistance.

Configure network settings for the NetEP device

1) Click on Start -> All Programs->Surveyor -> Tools-> NetEP Configuration Tool and the following form will appear.

Fig 2-3: Server settings

Fig 2-4: NetEP configuration tool

2) Click on Tools -> Network Configuration menu item, the Server Settings dialog will be displayed.

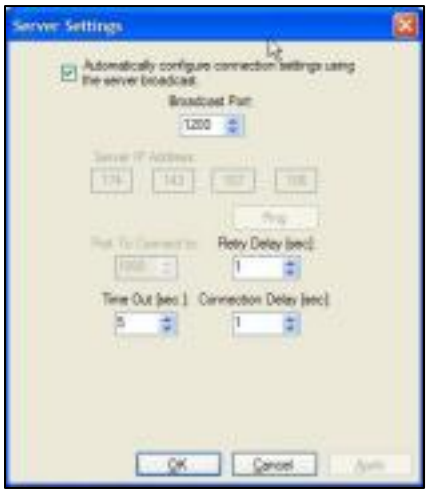


Fig 2-5: Server settings

3) If the server is configured to broadcast connection information then check the automatic server broadcast checkbox and fill in the broadcast Port with the same port number from the server. If the server is not broadcasting connection settings then uncheck automatic server broadcast checkbox, enter the Server IP Address and port to connect to.
4) Accept the defaults for delays and connection time outs. These should only be changed if having connection drops.
5) Click **OK** to save the information to the device settings.
6) When the NetEP Configuration Tool form appears, click **Start Service** to start the Baker NetEP Scheduler.

3
SKF Motor Condition Surveyor software interface

Database setup

The NetEP uses a database to store measurement results and other information needed for the monitoring of motors. Each NetEP device is mapped to a database in which its results are saved.

To create a database, login to the Surveyor software. On the **File** menu, select **New**, then **Database**. The following dialog appears.

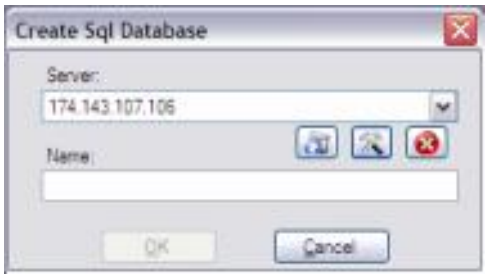


Fig 3-1: Create Sql database

In the Server field, select the IP address of the computer which is running the NetEP Server software using the down arrow in the Server field. Then enter the name for the new database to create and click on the **OK** button.

If a new NetEP server connection needs to be created (for example, during the initial installation of the NetEP system), click on the Create New Server Connection icon to bring up the following screen.

Fig 3-2: Connection settings

Type the Server Name (IP address) of the computer which is running the NetEP Server software in the Server Name field (the search icon can also be used to search for available servers). We recommend setting the port to 1433 and using SQL Server Authentication. Other ports and/or Windows authentication can be used, however expertise in network administration is recommended for utilizing these.

Clicking on the tools icon in the Create Sql Database window, brings up the following screen which allows you to change server connection settings once a connection is established. We recommend using the default ports and authentication modes unless experienced in network configuration and administration.

Fig 3-3: SQL Server connection settings

On this screen test the connection to the server by clicking the **Test Connection** button. This is useful for verifying that the Server Name (address), port, Username and Password are correct. Changing the port and authentication mode is discouraged unless you have experience in network configuration.

Once a database is created, a NetEP device needs to be mapped to the database. This tells the NetEP device which database to use to store its data. This is accomplished in the NetEP Surveyor software by selecting the Server Tree tab and right clicking on the database icon, and choosing the **Map** menu item. This will display all the NetEP devices connected to the server. Select the NetEP device that you want to use as the data source for this database.

Database Management

User Permissions

The Surveyor has four user roles for adding user permission levels of the software. In order to assign these roles to various users, an initial NetEP database must be created by a SQL system administrator account using Surveyor. The first time Surveyor creates a database user roles are created. At this time user logins can be assigned specific roles through SQL Server Management Studio. SQL Server Management Studio is a tool included with Microsoft SQL Server 2005 and later for configuring and managing Microsoft SQL Server. Below is a table of the user roles and the permissions assigned to each role.

	User Role			
	Administrator	**Analyst**	**User**	**Guest**
Folders				
Create	X	X	X	
Edit	X	X	X	
Delete	X	X		
Voltage Buss				
Create	X	X	X	
Edit	X	X	X	
Delete	X	X		
Map/Un-map	X	X		
Machines				
Create	X	X	X	
Edit	X	X	X	
Delete	X	X		
Map/Un-map	X	X		
Alarms				

Edit Alarm Value	X	X		
Enable Alarm	X	X		
Disable Alarm	X	X		
Acknowledge Alarm	X	X		
View Data	X	X	X	X
Add/Edit/Delete User	X			
Create Database	X			

Now that a connection with the NetEP server has been established, a database has been created, and a NetEP Device has been mapped to the database, we can create and map the motors to be monitored.

Select the **Location Tree** tab on the main Surveyor screen. This will allow motors to be organized in a logical order using folders. Right click on the database icon in the **Location Tree** and select the **New** menu item. The choices are: Folder or Voltage Buss. Folders are optional and can have other folders beneath them. Folders are a useful way of
organizing the motors to be monitored. Beneath folders can be another folder or a Voltage Bus. Beneath a Voltage Bus are the motors connected to that bus. An example of using folders to organize motors is shown below.

Fig 3-4: Database

Once a voltage bus and motor have been created, they must be mapped to a NetEP Device channel before monitoring can begin. To map a voltage bus or motor, select the **Server Tree** tab. This tab is organized with the databases at the top of the tree, with NetEP devices mapped to the database, Voltage busses mapped to the NetEP, and motors mapped to the voltage bus. The mapping consists of selecting the voltage or motor channel of the NetEP to which the voltage bus or motor is physically wired. For the example above, the following mapping options are shown when right clicking the NetEP icon, selecting Map Voltage Bus and the Voltage Bus icon, selecting Map AC Machine.

Fig 3-5: Select voltage bus

Notice that in the drop down menu for the Voltage Bus Channel and the CT input Channel, only the available channels are shown. That is, channels that are already in use are not shown. The maximum number of channels available depends on the specific configuration of the NetEP purchased.

If a mistake is made mapping voltage busses or motors, in the **Server Tree** view, right click the voltage bus or motor that was mis-mapped, and select **Unmap**.

Software interface overview

Login to the SKF Motor Condition Surveyor software. The main screen includes menu items on top of the screen, a Navigation pane to the left, a row of icons that change the view along the top and a large machine information pane.

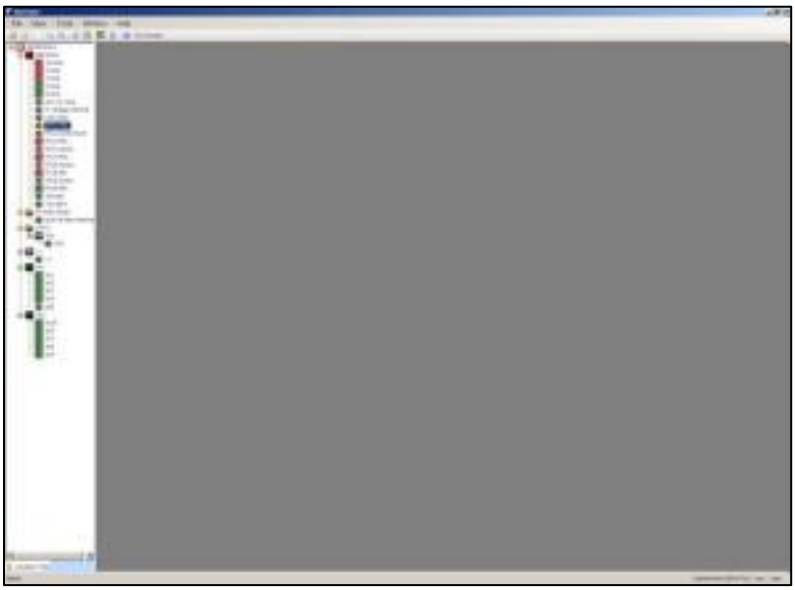


Fig 3-6: Opening Surveyor screen

Navigation pane

The Navigation pane can be turned on or off by clicking on **View** and then **Navigation Pane** and it will appear at the left side of the screen. The Navigation pane has two views available in it. The location tree that lists all the motors for a specific location and the server tree, which shows the connections of motors to NetEP's and NetEP's to databases. The Location Tree or Server Tree views are selected using the tabs at the bottom of the Navigation pane.

Server tree

If the server tree needs to be viewed, click on **View** and then **Server Tree** and it will appear at the bottom of the screen along side the Location Tree. This setting remains on until the screen is toggled.

Right Click Menu

The Navigation pane has several right mouse-click menus that offer capabilities and properties about motors, voltage busses and the database. This menu includes mapping and un-mapping of voltage busses, closing a database, exporting data via a .xml file, expanding the motor tree and properties of the selected motor.

On the root directory (database name) or Server level of the motor tree, the right-click menu

Fig 3-7: Right click menu - Server level

displays database activities such:

- New: Folder, Voltage Buss, or AC Machine
- Performance Log: pops up a grid showing time versus size of database. This tracks the growth of the database data.
- Close Database
- Compact and Repair: Compress data and repair corrupt data.
- Acknowledge All Alarms: This will acknowledge all alarms on all motors connected to this database. This is useful when an event has impacted many motors.
- Export data to .xml format.

Fig 3-8: Properties right click menu – Server level

The voltage buss right click menu contains the following.

Fig 3-9: Right click menu – Voltage buss

- Import: other MBD databases.
- Expand All: expands motor tree to lowest level.
- Properties: Set default for machine template.
- New: create a new AC machine
- Delete: will delete voltage buss and all machines under this voltage buss
- Close Database – close existing database.
- Export: data via .xml file format.
- Expand All: expands all AC machines located within the voltage buss.
- Properties: shows information about the voltage buss and the default template for AC machines. If an updated template for AC machines is created at this voltage buss level, it will override the default template created at the database level.

The right click menu for the AC machine level of the motor tree contains the following:

Fig 3-10: Right click menu AC Machine level

- Delete: AC machine.
- Close Database: Close currently open database.
- Export: to .xml file format.
- Properties: shows the AC machine properties.

Fig 3-11: Properties AC Machine Level

The name plate information is used in several NetEP calculations, therefore, it is important that the information entered is correct. For example, the NetEP calculates current level %, the name plate current is defined to be 100%. The **Off when Current Level <** box defines the current, in Amps, below which the NetEP assumes the motor is off and no longer collects or saves data for that motor while it is off. When the current level to the motor rises above this level, the NetEP automatically begins gathering data on the motor again.

The manufacturer information is saved for reference only and is not used in NetEP calculations.

On line testing has several parameters the NetEP uses for calculating motor performance. Do not change the default values unless you are certain that the new values are correct.

The Machine parts tab is used to define the bearings used in the motor. Knowing the bearing models allows the NetEP to calculate the bearing frequencies, and place markers in the spectra to locate potential problems with bearing degradation. The name entered here will also be shown on the spectrum marker selector to choose which frequencies on which to place markers.

Fig 3-12: Frequency – add machine parts

The Data Filter tab is where the data retention settings for the motor are entered. The default settings are for a server with a 4GB data size limit. This results in an aggressive data filtering set up. If you server database size is larger than 4 GB, the filter settings can be relaxed.

There are 3 levels of data filtering, Short Term, Medium Term and Long term. For each level of

Fig 3-13: Properties - Data filter

data filtering, a start time for that filter is defined in addition to the amount of data to retain of the alarm data, the Time Waveform data, and the Round Robin data.

To help plan your data filtering strategy, some data sizes will be helpful. A time waveform result is approximately 3.2MB each. A time waveform result is generated for each motor approximately once per hour. A round robin result is generated every 10 seconds for each motor and is approximately 2.6 KB each. By default, all alarm data is saved, so be sure that the alarm limits are properly set and motors are not always generating alarms.

Before the Short Term filter start time – in the example above, 12 hours – all data of all types is retained – nothing is deleted.

Once the Short Term filter start time has been passed, data older than this start time is filtered according to the settings selected. In the example above, all data which generates an alarm, regardless of whether it is Time Waveform or Round Robin, is retained. For Time Waveform data which does not generate an alarm, 1 Time Waveform per hour is retained, and for Round Robin data which does not generate an alarm, 3 Round Robin results per hour are retained.

The Medium Term and Long Term filters are set in a similar manner.

In the lower right hand corner of the Surveyor software window, the name of the database being used for the selected motor, the user login name, and the role of the user are displayed. To verify that the data filtering strategy selected is appropriate, monitor the size of the database as shown in the lower right hand corner. If the database is filling too quickly, a more aggressive filter set up may be required. Alternately, a larger capacity database server could also be installed.

Note: The NetEP will detect if the database is getting too full and will automatically start deleting the oldest data if the database has less than 500KB free space left.

Motor status visual notification

Around each motor is a background square that changes color according to motor status. This is based on the limits defined within the alarms tab. Default colors are green for all measurements within limits, blue for a measurement that exceeds the *watch* limit, yellow for a measurement in the *caution* area, red for a measurement in the *warning* area and grey indicates no data on this motor – this would most frequently occur when the motor is turned off.

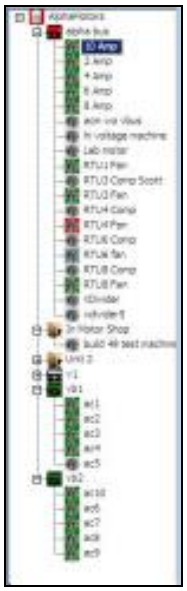


Fig 3-14: Motor status visual notification

If the measurements on a motor exceed the limits defined for that motor, not only will the motor icon background change color, so will the entries above the motor in the tree. Typically, this will mean that the voltage buss, folder and database icons will also change background color. This allows a quick method to determine if any motor is in an alarm condition. To determine which motor has exceeded the test limits, navigate down the tree looking for the motor with the same color background – note that there may be more than one motor, which has exceeded its alarm limits.

Motor information pane

Until a motor is selected, the motor information pane will be blank. Select a motor by double clicking on it in the Navigation pane. A single click will highlight the motor in the tree, but will *not* display the information for that motor – a double click is required. The title at the top of the window will indicate the displayed motor. The motor information pane has tabs both at the top, and often at the bottom of each view. The tabs along the top are for alarms, scheduler, dashboard, voltage/current, time waveforms, and trending. These tabs are discussed in detail in later chapters of this document.

Menu items

Click on **File** in the menu bar to create a new database, folder, voltage buss, or motor, to open or close an existing database, or to exit the program.

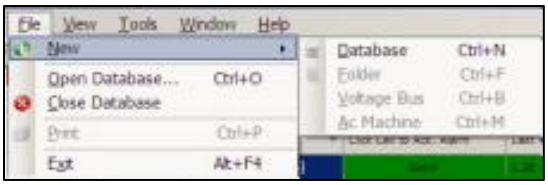


Fig 3-15: File menu

View

The View drop down menu contains refresh, navigation pane and server tree toggle boxes, the machine status grid and properties.

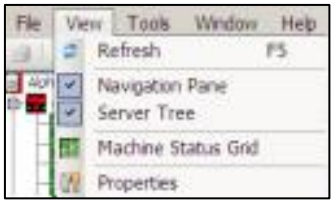


Fig 3-16: View menu

To see the status of all the motors in the databases open on the NetEP, select the Machine Status Grid view. The data grid displays a color-coded box for each monitored motor. This view can be toggled between two views. One view has large boxes and the other has small icons. This allows several hundred motors to be viewed at a glance. Default color coding is Green for all measurements within limit, Blue for a measurement that exceeds the *watch* limit, Yellow for a measurement in the *caution* area, Red for a measurement in the *warning* area. Grey indicates no data on this motor. By placing the mouse pointer in the colored box, a pop up will show the last measured data for that motor. To quickly navigate to the motor, double click on the square or icon in the Motor Status Grid View and the detailed motor results screen for that motor will be opened.

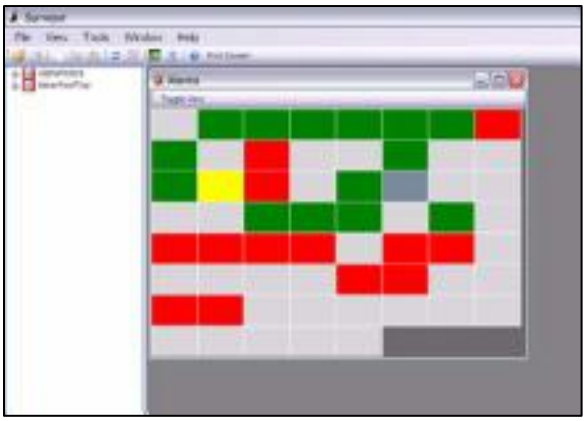


Fig 3-17: Machine status grid view

Fig 3-18: Motor status view

Tools

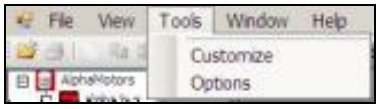


Fig 3-19: Tools menu

The tools view has two options. Customize and Options. The properties menu offers general options to how often the data is updated. Changing this will impact the performance of the system. Do not change this value without consulting Baker/SKF first. The advanced tab allows the resetting of default settings. The display units selection sets the default units for Torque, though both Nm and ft-lb are available throughout the Surveyor interface.

Fig 3-20: Properties general and advanced

Window

This menu offers advanced window views and a list of currently open views on the desktop. Some views may be open and not currently visible.

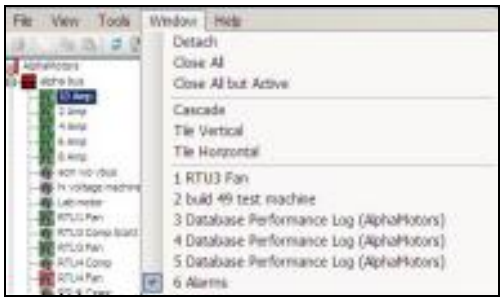


Fig 3-21: Window dropdown

To see detailed results for multiple motors at one time, use the Tile Horizontal selection to get a display line the one below – note that the windows for the different motors need to be open before selecting Tile Horizontal.

Help

Fig 3-22 Help menu

This menu contains the user manual in pdf format and an about screen to view what version of software is currently running on the NetEP, iNetEP.

Location Tree

The Location Tree view organizes motors and voltage busses in an intuitive manner. At the top of the tree is the database. Beneath the database, it is recommended that a folder (typically used to describe a location, for example, Plant 17 MCC 3) be created. Beneath the folder, create a voltage buss describing the buss and its connected motors. Finally, beneath the buss, create motors. Be sure to create motors that are connected to their specific voltage buss in the location tree. The location tree is not limited in the number of created voltage busses or motors. Use the location tree

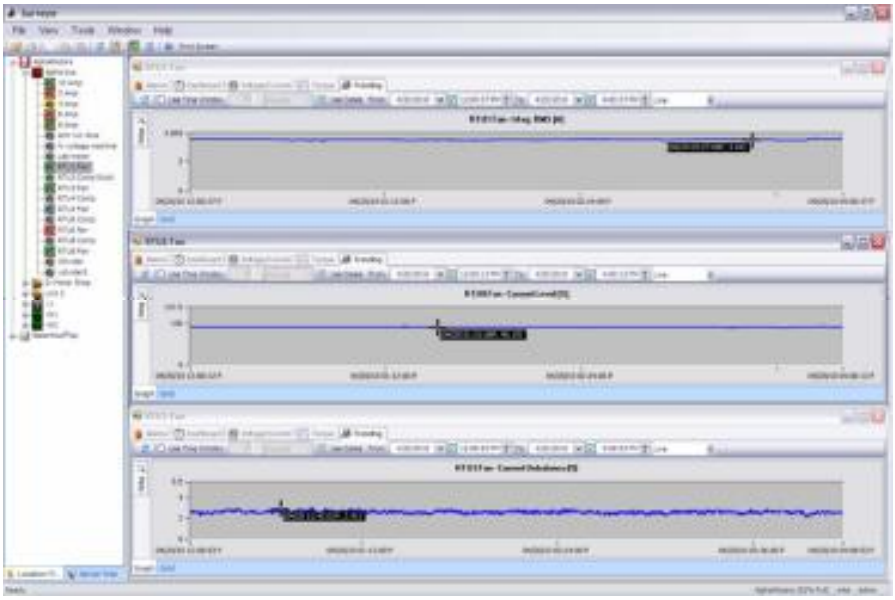


Fig 3-23: Tiled results

to organize motors and busses without regard to NetEP capacity.

Created items on the location tree are automatically saved to the database. There is no menu item to save the database.

Server Tree

The Server tree view of the Navigation pane is where mapping occurs of motors and voltage busses to NetEP devices. Click the **Server Tree** tab at the bottom of the Navigation pane to switch to the Server Tree view. As in the location tree, the database is located at the top. Right click on the database to add or map a NetEP device. A database can have multiple NetEP mapped to it. The number of NetEP which can be mapped to a database is set in the server configuration. Right click on the NetEP device to map a voltage buss to a measurement channel (1 through 7) on the device. Only available channels are shown for mapping. Right click on a voltage buss to map a motor to a voltage buss. As part of the voltage buss and motor mapping, the voltage or current channel used in the NetEP is selected.

Graph Tools

When in a graph (time waveform display, torque versus time, spectrum or trending in Use Dates mode), there are many options available to help inspect the graph.

Zoom: Click the mouse and drag the cursor to define the area to which to zoom. Dragging the cursor causes a dotted line to appear showing the area that will be displayed when the mouse button is released.

Zoom X-axis only: Click the left mouse button and drag the cursor straight parallel to the X-axis. The dotted lines showing the new display area will shift to vertical lines showing the portion of the X axis that will be zoomed to.

Zoom Y-axis only: Click the left mouse button and drag the cursor straight parallel to the Y-axis. The dotted lines showing the new display area will shift to horizontal lines showing the portion of the zoomed in Y-axis.

Cancel a Zoom: with the left mouse button still depressed, hit the escape key

To undo a Zoom: press the spacebar

Undo all Zoom: Press the Control and Spacebar keys simultaneously

Delta cursor: By default, the delta cursor has a green background. Click the left mouse button and drag the Delta cursor to the second point. Text will display next to the cursor showing the X and Y value changes between the two points.

Chapter 4
Parameter definitions & uses in diagnosing machine faults

Parameter definitions

The NetEP does two types of data acquisitions for monitored motors: Round Robin acquisition and Time Waveform acquisition. Both of these data acquisition types are automatically performed by the NetEP, there are no user adjustable settings for either acquisition type. The Round Robin acquisition is a fast measurement of motor voltages and currents. In a typical installation, every motor will have a Round Robin data acquisition taken on it approximately every 15 seconds. The Round Robin data is useful for monitoring overall power quality data as well as detecting momentary fluctuations in power or motor performance. The Time Waveform acquisition takes place approximately once per hour for each motor. This is an extended data acquisition that provides spectrum data and other machine parameters. The list of parameters measured or calculated from each measurement type is shown below.

Round Robin Measurements:

Voltages:

- Peak Voltage [LN - V]
- V RMS Avg. [LL - V]
- V RMS Avg. [LN - V]
- VA Peak [V]
- VA RMS[V]
- VAB Angle [deg]
- VAB RMS [V]
- VB Angle [deg]
- VB Peak [V]
- VB RMS[V]
- VBC Angle [deg]
- VBC RMS [V]
- VC Angle [deg]
- VC Peak [V]
- VC RMS [V]
- VCA Angle [deg]
- VCA RMS [V]
- Voltage Level [%]
- Voltage Unbalance [%]
- VUF [%]

Currents

- Current Level [%]
- Current Unbalance [%]
- Peak Current [A]
- I Avg RMS [A]
- IA Angle [deg]
- IA Peak [A]
- IA RMS [A]
- IB Angle [deg]
- IB Peak [A]
- IB RMS [A]

- IC Angle [deg]

- IC Peak [A]
- IC RMS[A]

Power quality

- c.f. I Avg
- c.f. Ia
- c.f. Ib
- c.f. Ic
- c.f. V Avg.
- c.f. Va
- c.f. Vb
- c.f. Vc
- Displ. PF a
- Displ. PF Avg.
- Displ. PF b
- Displ. PF c
- Harm. PF Avg.
- Harm. PFa
- Harm. PFb
- Harm. PFc
- PF Avg
- PFa
- PFb
- PFc
- V over F

Power

- App. Power a [kVA]
- App. Power b [kVA]
- App. Power c [kVA]
- App. Power [kVA]
- Frequency [Hz]
- Input Power [kW]
- Power a [kW]
- Power b [kW]
- Power c [kW]
- Reactive Power a [kVAr]
- Reactive Power b [kVAr]
- Reactive Power c [kVAr]
- Reactive Power [kVAr]
- Z Avg Amp. [Ohms]
- Z Unbalance [%]
- Za Amp. [Ohms]
- Za Ang. [deg]
- Zb Amp. [Ohms]
- Zb Ang. [deg]
- Zc Amp. [Ohms]
- Zc Ang. [deg]

Distortion

- Harmonic Distortion I [%]
- Harmonic Distortion V [%]

- HVF
- HVF A
- HVF B
- HVF C
- Td Ia [%]
- Td Ib [%]
- Td Ic [%]
- Td Va [%]
- Td Vb [%]
- Td Vc [%]
- THDi A [%]
- THDi B [%]
- THDi C [%]
- THDv A [%]
- THDv B [%]
- THDv C [%]
- Total Distortion V [%]
- Total Distortion I [%]

Components (symmetrical components)

- Ia1 Amp.[A]
- Ia1 Phase [deg.]
- Ia2 Amp.[A]
- Ia2 Phase [deg.]
- Va1 Amp. [V]
- Va1 Phase [deg.]
- Va2 Amp. [V]
- Va2 Phase [deg]
- Za1 Amp. [Ohms]
- Za1 Phase [deg.]
- Za2 Amp. [Ohms]
- Za2 Phase [deg.]

Machine

- NEMA derate factor

Time waveform acquisitions

In addition to all the parameters listed above, time waveform acquisitions include:

- Voltage Spectrum
- Current Spectrum
- Torque Spectrum
- Voltage Time Waveform
- Current Time Waveform
- Torque Time Waveform
- Air Gap Torque [ft-lb]
- Air Gap Torque [Nm]
- Eff. Service Factor
- Efficiency [%]
- Load [%]
- Load [hp]
- Load [kW]
- Rotor Bar Sideband [-db]

- Rotor Sideband Freq. [Hz]
- Speed [RPM]
- Torque [ft-lb]
- Torque [Nm]
- Torque Swing [%]

Components

Symmetrical Components are useful for troubleshooting asymmetries in a machine or power system. For machines, these are typically disconnected coil (cut out of the circuit), contact resistance in the circuit (not typical as these tend to burn out quickly), repair errors (inconsistent wire gauge or turn count, connection, reversed coil) resulting in asymmetries.

Symmetrical Components, describe the voltages and currents and impedance in a three phase power system. They can be decomposed into three phasors or components:

- the positive sequence phasor/component (V1, I1, Z1)
- the negative sequence phasor/component (V2, I2, Z2)
- the zero sequence phasor/component (V0, I0, Z0)

The positive sequence phasor or component works to rotate the shaft of the motor in the intended direction. Work performed by the positive sequence component has to overcome the negative sequence component before any real work can be done.

The negative sequence phasor would rotate a motor in the opposite direction that the shaft turns. Therefore, negative sequence components/phasors works against the positive component/phasor. A negative sequence component works to slow down the shaft as a brake would. All of this energy ends up as heat in the motor and is not good.

The zero sequence component/phasor is a ground current. In a balanced three phase system, the negative sequence term is zero. The NetEP assumes the phasor do not have a zero sequence.

Measurements available

I1: Positive sequence current amplitude
I1 Phase: Positive sequence current phase
I2: Negative sequence current amplitude
I2 Phase: Negative sequence current phase
V1: Positive sequence voltage amplitude
V1 Phase: Positive sequence voltage phase
V2: Negative sequence voltage amplitude
V2 Phase: Negative sequence voltage phase
Z1: Positive sequence impedance magnitude
Z1 Phase: Positive sequence impedance phase
Z2: Negative sequence impedance magnitude
Z2 Phase: Negative sequence impedance phase

Current

The current measurements are of each single-phase current – in RMS and peak. Limits should be set by using the nameplate data of the stator current. The aggregate Peak current, Avg RMS current and Avg RMS as a percentage of nameplate are also measured.

Too much current can overstress particular phases in the motor. The over current test determines if your motor might be drawing more than its rated current on one or more phases, causing excessive heat in the motor and decreasing the life of the insulation.

The nameplate information for every motor includes current data. The over current test compares the highest phases' current with the rated nameplate current and identifies overheating for that particular winding.

A typical thermal assessment for a winding examines a particular phase's current. The current generates I^2R losses, thus creating heat. Although not the entire cause for heat in the motor, I^2R losses are usually the main contributor.

Possible causes of high current:
Overloading: Will typically raise the current levels above nameplate.

Under-voltage: Every machine will either deliver the load required, or stall. The operating speed is mainly set by the operating frequency, and the load defines the required torque for that operating speed. The machine has to deliver the required torque that is now defined by frequency, and resulting operating speed. In order to deliver torque, the machine requires input power delivered by the voltage buss. If the voltage buss is low, then the required input power will have to be created by a higher current level.

Error in connection of machine: Errors connecting the machine will dramatically lower the inductance and resistance seen by the energized leads. Errors in connection will cause dramatic over currents, even when the machine is running with no load – literally free spinning. This error typically destroys the stators insulation health within a short time frame.

Mistake in machine rewinding: Mistakes in rewinding will change the properties of the machine. In this instance over currents is one of the possible outcomes.

Severe rotor cage damage: Rotor cage deterioration lessens the effectiveness of the rotor to generate torque with slip. The torque required by the load has then to be provided with a higher operating slip, which in turn causes higher rotor currents. These are then reflected as higher current levels in the stator.

Current Unbalance: Current Unbalance is measured in percentage. For machines with >50% load, this value is typically smaller than an eighth of the percentage voltage unbalance.

Unbalanced currents are frequently caused by mildly unbalanced voltages. A common rule of thumb is that voltage unbalance can be the cause of up to eight times larger current unbalances. Machines will also show very large current unbalances under very light, or no load conditions – even when driven by a balanced voltage. These current unbalances are common in healthy machines. These current unbalances vanish rapidly when the machine is loaded.

NEMA defines current unbalance according to the following equation:

$$\%I_{imbal} = 100\%.\frac{I_{Avg\_RMS} - \max\{(I_A - I_B) : (I_B - I_C) : (I_A - I_C)}{I_{Avg\_RMS}}$$

Where I_A, I_B , and I_C are the RMS values of the currents of the 3 phases, and I_{Avg_RMS} is their average.

Another way to analyze unbalances is via the negative to positive sequence ratio. This is the preferred method in the IEC standards.

Current Level [%]: I avg RMS as a percentage of full load where full load is defined from the nameplate

I Avg RMS: the average value of all three phases of current in RMS terms (RMS = root mean square).

Peak Current: the maximum current observed in any phase

Current Unbalance [%]: A measurement of the unbalance of the three currents supplying the motor. This is a NEMA type unbalance where the ratio is the maximum deviation from average divided by the average.

For each phase, A, B and C, the following measurements are provided:
I Angle (degrees): the phase angle of the phase current. All phase angle values for all measurements are in respect to the A phase voltage.

I RMS: the RMS value of the phase current. This is the current a digital volt meter would display when measuring the signal from the A phase CT.

I Peak: the peak current of the phase. The peak current is the actual maximum value of current observed by the CT and is the peak amplitude an oscilloscope would display when connected to the CT.

Distortion

Distortion measurements quantify how different a signal is compared to a perfect sine wave. AC rotating machinery works best when powered by a pure sine wave. Any power that is delivered to a motor that is not a pure sine wave creates heat in the motor. Therefore; the lower the distortion the better.

Distortion can arise from several different sources. For example, upstream transformers can saturate and warp the sine wave along with variable frequency drives (VFD's) creating noise on a voltage bus.

Total distortion (Td): is a ratio of the amount of a signal that is not in the fundamental frequency to the fundamental signal (either 50Hz or 60Hz). So the Td is a ratio of everything but the fundamental to the fundamental.

Total harmonic distortion (THD): is a ratio of the harmonics of the fundamental to the fundamental itself. Harmonics of 60Hz are 120Hz, 180Hz, 240Hz, etc. THD is very different from total distortion (Td), because Td will sum up all the frequencies in a signal and compare the sum to the fundamental, while the THD will just sum up the harmonic frequencies and compare the sum to the fundamental.

For example: a transformer with a phase saturating will cause the current in the saturated phase to have many harmonics of 60Hz. Therefore THD will be high. Td will also be high because Td will also sum up the signal at the harmonics of 60Hz as well as all other frequencies. Secondly consider a noisy VFD on a voltage bus. The THD of the bus voltage can be low, but the Td can be very high, all because the noise the VFD makes is not always at the harmonics of 60Hz.

Harmonic voltage factor (HVF): is widely used to de-rate the available power that should be taken from the motor without damaging the motor in the process. The Harmonic Voltage Factor is a weighted average of the odd harmonics of a voltage, except those harmonic with orders divisible by three. Specifically, HVF is

$$\sqrt{\sum_{n=5}^{n=\infty} \frac{V_n^2}{n}}$$

Where:
n= order of odd harmonic except those divisible by three
Vn= the voltage of the nth order harmonic. Again, harmonics eventually end up as heat and are not good for motors. As such, NEMA has derating curves for motors based upon the HVF.

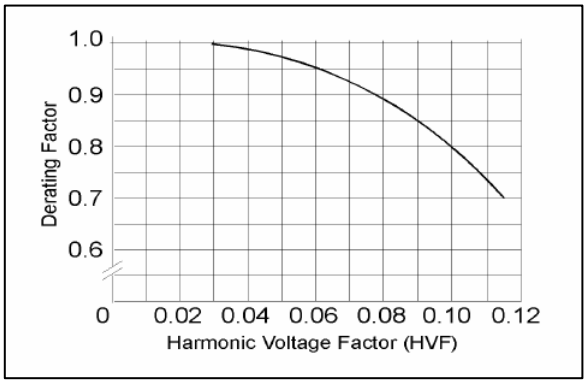


Fig 4-1: Derating curve for harmonic voltages

In deriving the HVF curve in Fig 1, NEMA assumes the only harmonics present are those included in the weighted average above. Specifically, any unbalances or other harmonics are not significantly contributing to the de-rating factor.

Aggregate harmonics measurements are:

- **Harmonic Distortion I [%]:** The average of the THD for all three phases of current.
- **Harmonic Distortion V [%]:** The average of the THD for all three phases of voltage.
- **HVF:** Harmonic Voltage Factor. The average of the HVF for all three voltage phases.
- **Total Distortion V [%]:** The average of all the distortion in the three phases of voltage.
- **Total Distortion I [%]:** The average of all the distortion in the three phases of current.

For each phase, A, B and C, the following measurements are provided:
HVF: Harmonic Voltage Factor for each phase.
Td I [%]: Total Distortion, in percent, of each phase current.
Td V [%]: Total distortion, in percent, of each phase voltage.
THDi [%]: Total harmonic distortion of each phase current.
THDv [%]: Total harmonic distortion of each phase voltage.

Dependencies of the harmonic data
If harmonics or noise sources are present in the voltage and current signals, the values listed above will increase. Using the transformer example above, an upstream transformer with a saturated phase will have increases in all of the distortion variables. With the measurements of all the phases and currents available, the offending phase can be identified.

Possible causes: THD I or Td I - saturating the iron in the motor. The motor being incorrectly connected to an excessive voltage level can cause this or if the motor has multiple voltage inputs the wrong voltage leads were connected to the voltage bus.

(Excluding VFD's) THD V, Td V – saturating transformer upstream. Another possible cause is if on the same bus, there are a high level of non linear loads (arc furnace, power electronics).

Machine data

The machine data measurements give key data regarding the machine load, efficiency, speed, rotor bar condition and de-rating.
Load is measured and reported in KW, HP and output Torque (both in NM and Ft-Lbs).
Load %: Expresses the delivered power of the motor to the name plate output power. 100% is a fully loaded motor while 20% is a lightly loaded motor.

Load KW: The power output of the motor expressed in KW

Load HP: The output power of the motor expressed in HP.

Air Gap Torque: is formed by the interaction of the magnetic flux in the gap and the current flowing in the rotor bars. The air gap torque is similar to the shaft torque, the difference being the friction & windage losses of the rotor and bearings is included in Air Gap Torque, but not in the shaft torque.

Torque: The shaft torque. Very close to Air Gap Torque but reduced by friction and windage losses. See section on Torque for more details.

Effective Service Factor: Divides the estimated percentage load into the NEMA de-rating factor. The service factor that a motor should be running at based on all the de-ratings caused by unbalanced currents, over/under voltages, harmonics, etc. It identifies how close the motor is operating to its effective service factor. The service factor test predicts heat-based deterioration and provides an accurate thermal assessment of the motor.

Efficiency: Estimates the efficiency (the ratio of the electrical power supplying the motor to the mechanical output power of the motor) of the motor under its particular operation conditions.

Poor motor performance displays reasons for stress in the motor. Excessive heat generated by the motor performance will destroy the insulation system causing premature electric motor failure. Properly diagnosed motor performance issues can either be avoided by correcting the root cause to the stress, or mitigates so future motor operation does not need to change.

Based on the measurements of voltage and current supplying a motor, the amount of shaft power the motor is producing is found, as well as how effectively the motor is converting electrical energy into mechanical energy. Any deviations from the norm can be used to de-rate the motor.

NEMA Derating: how much the full load of the motor should be de-rated based on current unbalances.

Rotor Freq [Hz]: the frequency where rotor bar frequencies will appear in current spectrum. For example: a 1780 RPM 4 pole motor has a slip frequency of 20 RPM or 0.33Hz. Broken rotor bars show up at the fundamental frequency (60Hz) minus slip (0.33Hz) = 59.67Hz.

Rotor Side Band [dB]: In spectrum plots, the difference between the fundamental peak and the side band peak caused by broken rotor bars. In the current spectrum, broken rotor bars peaks show up at the Rotor Freq (above example) which is very near the fundamental. In the torque spectrum, the broken rotor bar peak shows up at the slip frequency (0.33Hz in this example) very near zero frequency.

Speed [RPM]: the shaft speed in revolutions per minute.

Power data

Using the voltage and current measurements, the following list of power properties can be determined. Real power, apparent power, reactive power can be found as well as the power factor (PF). Real, reactive, and apparent powers are related to each other via the PF.

Apparent power = 3*I avg rms*V avg rms (where V avg rms is with respect to ground - not line to line)
Real power = (apparent power) * PF
Reactive power = (apparent power) * sqrt(1-PF^2)

There are numerous ways to do the calculations for determining real/reactive/apparent power. The formulas below show how it is done with arrays of voltage and current data:

First, calculate the RMS value for all three voltages and currents:

$$V_{a-rms} = \sqrt{[\Sigma_{i=0}^{Index_{full\_cycles}} Va^2(i)]/NPTS}$$
$$V_{b-rms} = \sqrt{[\Sigma_{i=0}^{Index_{full\_cycles}} Vb^2(i)]/NPTS}$$
$$V_{c-rms} = \sqrt{[\Sigma_{i=0}^{Index_{full\_cycles}} Vc^2(i)]/NPTS}$$
$$I_{a-rms} = \sqrt{[\Sigma_{i=0}^{Index_{full\_cycles}} Ia^2(i)]/NPTS}$$
$$I_{b-rms} = \sqrt{[\Sigma_{i=0}^{Index_{full\_cycles}} Ib^2(i)]/NPTS}$$
$$I_{c-rms} = \sqrt{[\Sigma_{i=0}^{Index_{full\_cycles}} Ic^2(i)]/NPTS}$$

Calculate the apparent power by multiplying the RMS voltages and currents together on a phase by phase basis:

$$P_{apparent} = V_{a-rms} * I_{a-rms} + V_{b-rms} * I_{b-rms} + V_{c-rms} * I_{c-rms}$$

The real power is found by summing the voltages and currents per phase on a point by point basis as shown below:

$$P_{real} = (1/Index_{full\_cycles}) \sum_{i=0}^{Index_{full\_cycles}} [Va(i) * Ia(i) + Vb(i) * Ib(i) + Vc(i) * Ic(i)]$$ The power factor becomes

$$PF = P_{real} / P_{apparent}$$

The reactive power becomes

$$P_{reactive} = P_{real} * \sqrt{(1 - PF^2)}$$

Aggregate Power Measurements
Frequency (Hz): The fundamental frequency of the power system (i.e. 50Hz, 60Hz)
Input power (KW): The real electrical input power to the motor
Apparent power (kVA): Total apparent power in kVA. Equals the sum of the three phase's apparent power.
Reactive power (kVAr): Total reactive power in kVA. Equals the sum of the three phase's reactive power.
Z Avg Amp: Average of the three phase's impedance amplitudes
Z Unbalance [%]: Unbalance of the three phase's impedance amplitudes using the NEMA formula for unbalance.

The following measurements are provided for each phase:
Apparent power phase (kVA): Apparent power of the Phase
Reactive power phase (kVAr): Reactive power of the Phase
Real power phase (power): Real power of Phase A
Z Amp: Phase impedance. Equals V-rms/I-rms.
Z Angle: Phase impedance phase angle. Equals Ang(V)-Ang(I)

Power quality

The nameplate of the motor specifies operating voltage level and frequency for the motor. Under optimal conditions, the motor will operate at 100% voltage level, 0% voltage unbalance and 0% voltage distortion.

Power condition problems particularly deteriorate the motors that are operating at higher load points, or with more frequent cycle times.

Given the high resolution measurements of the three voltages and currents, power quality information can be obtained. Power quality affects how well the motor can convert the electrical input power to mechanical output power. As described in the harmonics section, motors work best when they are powered by a pure sine wave. Unfortunately, power systems and loads can distort the sine wave. The motor can still operate, although the motor becomes less efficient at producing mechanical power.

The motor itself can have an effect on the power system, mainly by the phase angle between the voltage and current drawn to power the motor. This phase angle is represented by the power factor (PF).

On an individual phase basis, the power factor becomes:

$$PF_a = P_{real-a} / P_{apparent-a}$$

Where

$$P_{real-a} = (1/\ Index_{full\_cycles}) \sum_{i=0}^{Index_{full\_cycles}} [Va(i) * Ia(i)]$$

And

$$P_{apparent-a} = V_{a-rms} * I_{a-rms}$$

A= Phase A. The same formulas are used to determine the power factors, apparent power, and real power of the phase B and phase C.

The displacement power factor and the harmonic power factor are concepts used understand the contributions to the overall power factor provided by the fundamental power frequency and the contribution by the harmonics as shown below:

$$PF = (DisplacmentPF) * (HarmonicPF)$$

The displacement power factor is an artifact of the motor and its inductive nature. The harmonic power factor is due to the motor's inductive nature and the characteristics of the power system. By splitting up the power factor into two pieces, the properties of the motor that are independent of the power system can be observed even though the power system itself is changing.

Another way to view the three power factors is as follows:

- PF = the power factor of the system
- Displacement power factor = the power factor of the fundamental power frequency
- Harmonic power factor = the contribution from all the other frequencies not in the fundamental. HarmonicPF = PF / DispPF.

Crest factor

The crest factor is often used to describe how well a waveform looks like a sinusoid. The definition of Crest Factor (c.f.) is

$$c.f. = \frac{V_{peak}}{V_{RMS}}$$

The table below shows the c.f. various waveforms.

Wave type	Waveform	Peak magnitude (rectified)	RMS value	Crest factor	Crest factor (dB)
DC		1	1	1	0.0 dB
Sine wave		1	$\frac{1}{\sqrt{2}} \approx 0.707$	$\sqrt{2} \approx 1.414$	3.01 dB
Full-wave rectified sine		1	$\frac{1}{\sqrt{2}} \approx 0.707$	$\sqrt{2} \approx 1.414$	3.01 dB
Half-wave rectified sine		1	$\frac{1}{2} = 0.5$	2	6.02 dB
Triangle wave		1	$\frac{1}{\sqrt{3}} \approx 0.577$	$\sqrt{3} \approx 1.732$	4.77 dB
Square wave		1	1	1	0 dB

Fig 4- 1: Crest factors for various waveforms. From Wikipedia.

The c.f is seldom used in the motor industry. However, in the general design of magnetic circuits, the c.f. can prove useful in properly sizing cores given the type of waveform a core will see. For example, the core dimensions will be different if a core sees a square wave with c.f.=1. If the core sees a sine wave, it's dimensions can be smaller.

V/F is a ratio of the excitation voltage of the core to the frequency of that excitation. Cores are designed to stay out of saturation at their design voltage and frequency. If the voltage is allowed to increase, the core will saturate and heat up. If the frequency is allowed to slow down, the core will again saturate and heat up. Consider the definition of flux:

$$\Phi = \int V dt$$

If a voltage is present for a long time, the flux Φ can become very large and drive the core into saturation. Likewise, if the voltage is too high, the flux can become large and again drive the core into saturation.

Keeping the V/F ratio constant is required to keep core losses minimized. The V/F ratio is of special interest for VFD driven motors where the V/F ratio is a key setting to configure the drive.

Aggregate power quality fata:
c.f. I Avg: The average Crest Factor of all three currents.
c.f. V Avg: The average Crest Factor of all three voltage
Displ PF Avg: Average of Phase A,B,C Displacement Power Factors
Harm PF Avg: Average Phase a,B,C Harmonic Power Factors
PF Avg: The average of Phase A,B,C (real or total) Power Factors
V over F: The ratio of Voltage to Frequency.

Data is provided for each phase:
c.f I: The Crest Factor for each Phase current
c.f. V: The Crest Factor for each Phase voltage
Displ PF: Displacement Power Factor for each Phase
Harm PF: Harmonic Power Factor for each Phase
PF: The (real or total) Power Factor for each Phase

Voltage

Poor voltage conditions will expose the motor to additional unnecessary stress. This stress will be noted, most significantly, in additional heat in the motor, which is the main insulation deterioration mechanism. NEMA and EASA suggest the rule of thumb that for every 10°C of additional heat to the windings, the motor's insulation life is reduced by half.

Power condition problems usually come from up-stream. The motor is exposed to a stressing voltage condition, which generally is created by the power distribution system (voltage source).

Power condition problems affect the whole voltage bus, and not only the motor that is being currently monitored. Hence, if the problem is fixed, all motors on this bus will benefit, and longer lifetimes can be expected.

Common problems can consist of wrong settings on the supply transformer's taps, poorly distributed single-phase loads, and overloading (saturating) supply transformers.

Aggregate voltage data:
Peak voltage [LN-V]: The maximum line to neutral voltage of the three phases.
V RMS avg [LN-V]: The average RMS line to neutral voltage
V RMS avg [LL-V]: The average RMS line to line voltage
Voltage level [%]: The percentage of actual voltage to nameplate voltage
Voltage unbalance [%]: The unbalance of the three voltages using the NEMA definition for unbalance.
VUF [%]: Voltage unbalance factor. Equals the ratio of negative sequence voltage and the positive sequence voltage. Similar to the NEMA unbalance, but more accurately reflects the effect of unbalanced amplitudes and phase angles on motor performance.

The following are available for each phase:
V Peak [V]: The peak voltage for the phase (line to neutral)
V RMS [V]: The RMS voltage for phase (line to neutral)
V Angle [degrees]: The angle between two phases line to line voltages
V RMS [V]: The phase to phase line to line voltage in RMS. This is the value measured by a hand held digital volt meter measuring between phases.

Voltage, current and torque spectrum

The spectrum window (available in voltage/current and in torque) is used to analyze the frequency spectra of the three line-neutral voltage waveforms, the three line currents and the torque independently of each other. The current spectrum contains information related to the vibration spectrum of the machine, among other things. It is possible to identify roller-bearing faults by using the Mark Frequencies option. It is also feasible to find deteriorating alignment problems, load unbalances, looseness, eccentricity, and cavitations by analyzing the spectrum.

Note: It has been shown that it is possible to identify the above mentioned faults using the current spectrum. However, the locations in the spectrum that display the signatures of any particular fault differ noticeably from the frequencies where vibration analysts identify particular fault types. This is due to the modulation of the frequency of interest onto the fundamental (50 or 60 Hz). Experience has shown that it is significantly easier to diagnose mechanical faults using the torque spectrum, since the modulation of the fundamental is not present in the torque spectrum. It also needs to be noted that the torque spectrum noise floor is typically almost one decade lower than in the current spectrum.

Rotor Bar

The rotor bar marker identifies electrical asymmetries in the rotor circuit of induction machines of either kind: Squirrel-cage (manufactured or die-cast rotor design), and wound rotor design.

Broken rotor bars can cause excess heat in the motor, decrease efficiency, shorten insulation life, and possibly cause core damage.

The rotor bar marker identifies salient frequency components, which are generated by a degrading rotor cage in the current spectrum. The rotor bar alarm compares the magnitude of the rotor bar frequencies to the limits on the alarm setup page.

Possible root causes of electrical asymmetry:

Cage rotor designs:

- Broken or cracked rotor bars
- Broken or cracked endrings
- Uneven quality of electrical connection between bars and endrings for manufactured cage designs
- Porosity in the squirrel cage of die-cast cages is very common, and frequently represents no problem to the lifetime of the machine.

Wound rotor designs:

- Uneven brush-ring connection quality
- Unbalanced rotor-resistance circuit
- Unbalanced contact resistance in external rotor-circuit shorting bridge.
- A turn-turn short in the rotor-winding

Electrical asymmetries in the rotor circuit create currents at various frequencies. It has been shown that an increasing amount of electrical asymmetry cause these currents' amplitudes to rise.

Literature shows that the particular signature frequencies of the rotor currents f_r depend upon two variables: the fundamental frequency f_N (typically 50Hz or 60Hz for most networks), and the amount of slip s with which the induction machine is being operated.

$$f_T * h,k) = f_N \cdot (h + k \cdot 2 \cdot s)$$

Where:
h = a whole number >0 that represents the electrical harmonics
k = is a whole number and
slip s = is defined as:

$$s = \frac{SySP - OpSp}{SySp}$$

Where:
SySp= denotes synchronous speed
OpSp= stands for operating speed.

The most accepted method for the diagnosis of rotor circuit asymmetries during operation by means of electrical measurements is the Lower Side-band method. It compares the current amplitude at one particular frequency (*h=1, k=-1*) of these signature frequencies to the current amplitude at the fundamental frequency.

This particular signature is called the Lower Side-band, because it's location at the lower side-band of the fundamental current, as can be seen in the following equation:

$$f_{rh=1,k=-1} = f_n(1-2\cdot s)$$

The signature is shown in the spectrum display; a graph that plots the current components vs. frequency. The current components are normalized to the amplitude of the fundamental current, and displayed in dB.

The tallest peak of the currents is the fundamental current – 50 or 60 Hz. The fundamental peak shows one side-band to each side. The automated red-yellow-green-blue assessment made by the software depends upon the amplitude of the current component at the frequency identified by the rotor bar marker compared to the limits defined in the alarm setup page.

The effect of rotor circuit asymmetries can also cause various other symptoms in the frequency domain.

Torque

As an asymmetric rotor feature enters and leaves the magnetized portion of the circuit, it modulates the ability of the rotor to generate torque. Large asymmetries can be seen in the torque graph.

This modulation may not be easily visible in the time domain if other torque-signature frequencies are of significance. If this is the case, switch to the Torque Spectrum where individual frequencies are separated from each other, making a diagnosis easier.

Other harmonics can be used to attempt to verify rotor circuit asymmetries. If present, these amplitude peaks are so low that it is advisable to display the spectrum on a logarithmic scale. This verification is typically done by focusing on one particular h-value, and expecting to see many peaks at various k-values.

The most common h values used are:

Torque: 6, 12, 18, …

Current: 5, 7, 11, 13, 17, 19, …(odd numbers not divisible by 3)

Deteriorated cages or poor brush-ring contacts decrease the start-up ability of the machine. Trending startup times for a motor-load system can be used as an additional measure to identify potential issues.

Note: The startup ability of a machine is strongly influenced by the voltage level, load torque versus speed profile, and inertia. Any changes to these variables will influence the startup time, potentially causing false positive or false negative assessments.

Rotor asymmetries will also affect the torque-speed curve, decreasing the amount of torque the machine can deliver for every speed. For steady-state operation, this results in higher slip being necessary for producing the same output torque. **Note**: This effect is very slight for mild to moderate amounts of asymmetry, yet it keeps growing disproportionately for incremental increases of asymmetry.

Avoidance/Mitigation

The potential of a false positive diagnosis delivered by any signature-based diagnostic technique should be verified using at least one different, non-related technology. Motor Current Signature Analysis and vibration analysis are the techniques most frequently used together to provide cross-verification of the obtained assessment.

After verification of unacceptably high amounts of rotor circuit asymmetry several action paths open:

Wound rotor induction machine
It may be possible to safely do any of the following while the machine is still in operation: visually inspect, or take thermo-graphic pictures, or take voltage drop readings at the brushes, brush rings, and the external circuit connecting the brushes. Resistance and inductance balance readings of the rotor windings can be taken once the machine is de-energized and in standstill. These types of measurements may help to pin-point the root cause of the lacking symmetry of the rotor circuit that was observed via the stator currents.

Squirrel cage induction machine

Rotor bar and rotor-slot shape: The potential ability of a broken rotor bar to dislodge itself from the rotor slot and wedge itself into the airgap typically influences the action taken when unacceptably high rotor circuit asymmetry has been diagnosed and verified by two separate and independent diagnostic techniques. A machine in which rotor bars have the potential to wander into the airgap is under threat for failure, and is more likely to be scheduled to immediate or prompt corrective action. Conversely, a rotor bar design that is captive in the rotor iron faces a more gradual deterioration, allowing a less intrusive schedule for corrective action.

Diecast or manufactured squirrel cage: A second motor-design based differentiator is whether the squirrel cage is die-cast, or manufactured. The former can have porosity resulting from its manufacture, whereas the latter cannot. Especially for smaller motors, porosity is a common imperfection. It only poses a risk to reliability if it is excessively severe. Examples of symptoms of excessive porosity are: a decrease of the motor's startup torque capability that falls below the applications' requirements; excessive slip during steady-state operation that interfers with the application; excessive operating temperature decreasing the insulation's expected life; excessive vibration, etc.

Diecast squirrel cages can develop broken bars – even though this happens less frequently than for manufactured squirrel cages. It may be advisable to monitor a diecast squirrel cage machine more frequently if high amounts of asymmetry are found the first time it is monitored. If the root cause was porosity, then the amount of asymmetry is unlikely to rise as time goes by – and the period between measurements may be relaxed. If the diagnosed asymmetry rises as time goes by, then a situation of broken bars is likely, requiring corrective action.

Manufactured squirrel cages cannot have porosity. Here, rotor asymmetries are probably due to either a weak electrical joint between rotor bar and end-ring (failure prone in the future), or most likely due to the stress seen by the machine during normal operation. This is worsened by the fact that now the squirrel cage is weaker than it was when it first sustained damage, making it more failure-prone.

Mitigation
Safety, criticality, cost of replacement, cost of repair, down-time to replace, cost of down-time, availability of replacement, redundancy and availability of capital are just some of the circumstances that help define a suitable course of action. The particular failure mode of broken bars may offer the course of action to manage the deterioration for motor designs with captive rotor bars. It is known that broken bars occur most frequently during line-start processes. Some applications are designed with multiple motors in parallel that can be switched on or off depending upon the

momentary requirements. It may be worth assessing whether a captive rotorbar motor diagnosed with broken bars can be left running continuously until the next planned outage, and expose the other motors to the start and stop operation.

Rotor bar test: False assessments
It is good practice to cross-verify any signature-based assessment via a second unrelated technology to rule out false positives, and decrease the risk of false negative assessments.

What are the common sources of false assessments?

1) Current measurements must be done correctly

2) Power Quality requirements: Constant Voltage level, Constant Frequency, low noise floor

3) The machine must be running with sufficient slip

4) Load level must be sufficiently constant

5) Assessment needs to not be influenced by possible natural frequencies of the motor-load system

6) Speed assessment must be correct

1) Current measurements must be done correctly.
a) Ensure that current measurements are valid. There is no overloading, no under-voltage conditions, if the motor has just been installed (or re-installed) there are no errors in connection of machine, and if the motor has been rewound, there are no mistakes in machine rewinding.

2) Power quality requirements: Constant voltage level, constant frequency, noise floor.
a) The determination of the rotor bar frequency is based upon the knowledge of slip, which depends of synchronous speed and operating speed. Both these numbers need to be correctly known in the software to have a properly calculated rotor bar frequency

b) The rotor bar assessment is done on a spectrum measurement. The analysis of this spectrum can only be valid if steady-state conditions are met. Changes in voltage level or in frequency directly affect the operating speed of an induction machine, hence breaking the requirement of steady-state speed during the time waveform acquisition, typically 240 seconds.

c) Ensure that the noise floor of the current spectrum is sufficiently low (20 dB or more) to allow sufficient separation from the current spectrum to the rotor bar limits.

Note: A significant number of applications exist where lowering the noise floor sufficiently may be hard to accomplish. Examples: Crushers, conveyor belts, and pulpers.

d)Insufficient separation is the source of false positive assessments.

e) Use the trending page to examine data of sufficient length (~10 minutes) for gaining a good understanding of the application's power quality. Look at the V(t) and f(t) traces and ensure that they are a solid (<1% variation) constant. If this requirement is not met, then the data is known to be invalid for rotor circuit asymmetry assessments.

3) The machine must be running with sufficient slip.
a) The rotor asymmetry signature is adjacent to the electrical fundamental and has an amplitude that is typically orders of magnitude smaller.

b) Sufficient separation in frequencies between the electrical fundamental and the signature frequency is required to make an assessment possible.

Note: Applications exist where it is impossible to create insufficient separation between the fundamental and signature frequency. Examples of applications: Motors that are free spinning (mechanically uncoupled), or most MOV's, which run at very low loads during the constant load stroke which is of too short of a duration to allow sufficient separation of these frequencies.

c) Increasing the load to the motor will increase the operating slip, moving the signature peak further from the peak of the electrical fundamental.

4) Load level must be sufficiently constant.
The rotor circuit asymmetry assessment number is calculated from the amplitudes of the signature (rotor bar) frequency and the fundamental frequency currents.

a) This sets the requirement of knowing the signature frequency, which depends upon knowledge of the operating speed.

b) The machine's speed changes as a function of load requirements (dampened by the system's inertia).

Note: A significant number of applications exist where this requirement cannot be met.
Examples: Most mills, cranes, centrifugal shoots, and many applications that require a design D motor due to dynamic loading.

c) Look at every data point's torque ripple graph and ensure that the short-time torque ripple is sufficiently constant to conclude that the rotor bar graph's data is valid.

d) If the validity of the data is uncertain due to significant torque ripple, AND rotor circuit asymmetry signature is present, do the following: Look at every datapoint's torque ripple and ascertain whether the nature of the torque ripple varies from one datapoint to the other. If this is the case AND the rotor circuit asymmetry signature remains consistent, then a rotor circuit asymmetry issue is likely.

5) Assessment needs to not be influenced by possible natural frequencies of the motor-load system.

Mechanical, or electro-mechanical systems can operate such that natural frequencies near rotor circuit asymmetry signatures are excited. These excited resonant frequencies are the source of possible false positive assessments.

Note: The nature of motor current signature analysis is different from vibration analysis in several ways. One of these differences is that vibration analysis' information represents the local nature of the system, whereas motor current signature analysis information is more analogous to a sweep alongside the energy conveyed to the system. Any electrical or electro-mechanical feature influencing the flow of energy (e.g. setting off resonances) has the capability of attaching these frequencies to the spectra obtained through electrical measurements.

a) If a significant rotor circuit asymmetry signature peak has been identified, verify that it is not a mechanical or electro-mechanical resonance by varying the load. A load variation will vary the machine's speed only very slightly (hence the resonance will probably still be excited). However, the

slip will vary in proportion to the percentage load change – shifting the rotor circuit asymmetry signature significantly, while keeping the system's natural resonant peak in the same location.

6. Speed assessment must be correct for the data point
a) The speed must be constant through acquisition and correct in the software

b) Verify that the machine is operating at the speed displayed by the software by reading it with other means (e.g. a strobe). If this is unrealistic, use the Trending display of Speed to verify that the speed estimates are consistent.

Torque
This domain specializes in diagnosing mechanical issues, displays transient overloading, and locates soft-foot mechanical imbalances along with bearing problems. Torque signature analysis shows far more dramatic results, giving greater confidence in finding and diagnosing problems.

As an asymmetric rotor feature enters and leaves the magnetized portion of the circuit, it modulates the ability of the rotor to generate torque. Large asymmetries can be seen in the torque graph.

This modulation may not be easily visible in the time domain if other torque-signature frequencies are of significance. If this is the case, switch to the torque spectrum where individual frequencies are separated from each other, making a diagnosis easier.

Torque : The torque time wave form shows the load stress imposed on the motor. RMS quantities are an accurate measure of the average energy contained in the instantaneously changing current or voltage signal. If only RMS quantities are monitored, it is impossible to find peak stresses in the motor's load. Instantaneous waveform analysis monitors the time-varying or instantaneous variations in the load. Thus, the torque time waveform can identify peak pulses above the motor's nameplate information, even if the average power delivered to the load does not exceed the nameplate data. A significant portion of a motor's performance can consist of transient load fluctuations. Copper losses and their associated heating are proportional to the square of the currents. Thus, transient load fluctuations are just as significant as the average value of the operating torque.

The torque time waveform shows the torque propelling the load. Any transients or variations in the load component should prompt further investigation. For example, the influence of broken fan blades or worn roller bearings on a conveyor belt can be seen on the torque time waveform display.

Torque swing is the percentage of the transient torque to the steady state in percent:

$$\%\,torque\,swing = \frac{100 \cdot (Peak\,torque - Steady\,state\,torque}{Steady\,state\,torque}$$

5
Alarms

Alarms tab overview

The alarms tab is where motor specific measurement limits are set, viewing of detailed enabled alarm status, and acknowledge alarms is done.

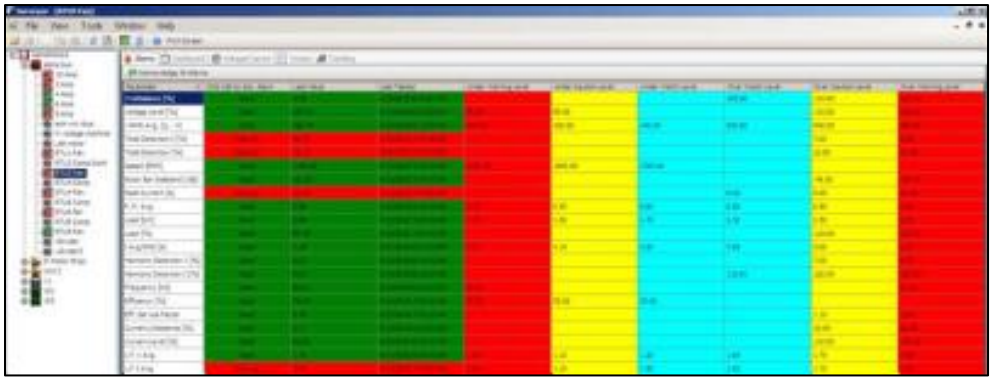
Note: This view is a motor specific tab. It shows information for one motor at a time. The overview of all alarm status is done via the motor selection pane or the machine status grid view. At the bottom of the alarm window, there are two tabs – alarm setup and alarm status.

The alarm setup tab contains key measurements and motor limits defined for each parameter. Not all parameters need to have limits, or need to be enabled for alarming. The list of measurements available for setting alarms is shown on the left of the alarm setup tab view. For each measurement, a high and low watch, caution and warning limit as well as the alarm enable for the measurement can be set. If the alarm for the parameter is enabled, the limits will be compared to the data gathered during monitoring of the motor. If exceeded, the background color of the motor icon in the motor selection pane will change color, as will the grid box corresponding to the motor in the machine status grid view.

Alarm status can also be indeterminate, not evaluated or disabled. Indeterminate indicates an enabled alarm, but an unmeasured specific parameter. This typically occurs when an alarm is enabled on a parameter, which requires a time waveform acquisition, but a time waveform acquisition has not yet run on the motor.

Note: time waveform acquisitions occur approximately once per hour. Not Evaluated is coded a light grey color and indicates that no data is available for this motor; therefore, it is not evaluated. This typically occurs when a motor has been defined in the location tree, but has not been mapped to a NetEP channel in the location tree. A Disabled motor is set up and mapped to a NetEP channel; however, the motor is off at this time. While a motor is off, the NetEP automatically disables data collection on that motor. When the motor restarts, the NetEP will automatically begin taking data on it again. The threshold for determining if a motor is off is found in the name plate information in the motor properties screen.

The Alarm Status tab shows the status of all enabled alarms for this motor, as well as last measured values of enabled alarm parameters. A motor alarm condition is set when limits exceeded parameter levels. The alarm condition is not cleared on a subsequent measurement of this parameter within limits, rather the alarm must be acknowledged by the user before it is



cleared.

Fig 5-1: Alarms

Acknowledging alarms

When an alarm is triggered, it remains set until it is acknowledged regardless whether or not subsequent measurements of the motor parameter which set the alarm exceed alarm limits or not.

1) To acknowledge an alarm, navigate to the motor causing the alarm condition by double clicking on the motor in the motor selection pane, or double clicking on the icon or rectangle in the data grid view.

2) Go to the Alarm Status screen for that motor. The parameters which set the alarm status will be color coded, corresponding to the type of alarm; blue for watch level, yellow for caution level and red for warning level.

3) Clear the alarm by clicking on the Click to Acknowledge Alarm column on the color coded motor parameter.

4) A dialog box appears to clear the alarm.

5) Click yes to clear the alarm status for that motor parameter.

6) The status will change to Acknowledged and the next time this parameter is measured, the alarm status will be updated, based on the measured value.

7) If multiple parameters have exceeded alarm limits, each must be cleared individually as described above or all alarms for a motor can be cleared by clicking the Acknowledge All Alarms at the top of the Alarm Status screen.

8) **Note**: acknowledge all alarms for this motor by using the Acknowledge All Alarms button at the top of this window. This is useful in a situation where, for example, the voltage buss momentarily sagged, triggering voltage as well as current alarms.

9) If an event occurred which affected all motors connected to the NetEP, all the alarms can be cleared at the database level by right clicking on the database icon in the Motor tree, and selecting the Acknowledge all alarms item.

Alarm parameters

The motor parameters that can have alarm limits set for them are:
Load [%]
Load [kW]
Power Out [kW]
Rotor Bar Sideband [-db]
Speed [RPM]
Efficency [%]
Eff. Service Factor
Impedance Unbalance [%]
Za
Za angle
Zb
Zb angle
Zc
Zc angle
NEMA Derat.
Input Power [kW]
P. F. Avg

Fig 5-1: Alarm status view

Frequency [Hz]

Current Unbalance [%]
Current Level [%]
Harmonic Distortion I [%]
I Avg RMS [A]
I Peak
Total Distortion I [%]
c.f. I Avg
Voltage Unbalance [%]
VUF [%]
Voltage Level [%]
Total Distortion [%]
V avg RMS [V]
Peak Voltage [V]
Harmonic Distortion [%]
HVF
c.f. V Avg.

These parameters are on the alarm setup tab.

Each motor parameter can have six limits associated with it, low warning, low caution, low watch, high watch, high caution, high warning. To set an alarm value, type the parameter value into the appropriate cell in the alarm setup table.

Note: that for parameter limits with no alarm wanted leaves the corresponding alarm cell in the setup table blank. For example, the rotor bar sideband would most likely be blank for the low warning, low caution and low watch alarm levels. Alarm limits must be ordered correctly – the low warning level must be lower than the low caution level, and the low caution level is lower than the low watch level. Similarly, the high warning level must be higher than the high caution level which is higher than the high watch level. The high watch level must be higher than the low watch level.

After entering the parameter alarm limits for the motor, click the **Apply** button near the top of the alarm setup screen, otherwise changes will be lost. At the top of the alarm setup screen is the Undo All Changes button. Clicking this button to remove all edits made in the alarm setup screen and restore all entries to their previous value.

The restore defaults button will load factory pre-set values for all motor alarm parameter limits and actions. If after examining the defaults, you would prefer not to use them, click the undo all changes button to restore the previous values.

Use caution when setting Alarm Limit Values

1) If alarm limits are set too tight, many nuisance alarms could be set, requiring frequent intervention to acknowledge the alarm state.

2) Alarm data is saved. If alarm limits are set such that every reading on the motor results in an alarm condition (that is, one or more of the limits have been exceeded), the data for the alarm is stored in the database. This can quickly fill the database with the data associated with the alarms, requiring an administrator to manually clear out database entries. Having excessive amounts of data in the database can also slow the responsiveness of the interface.

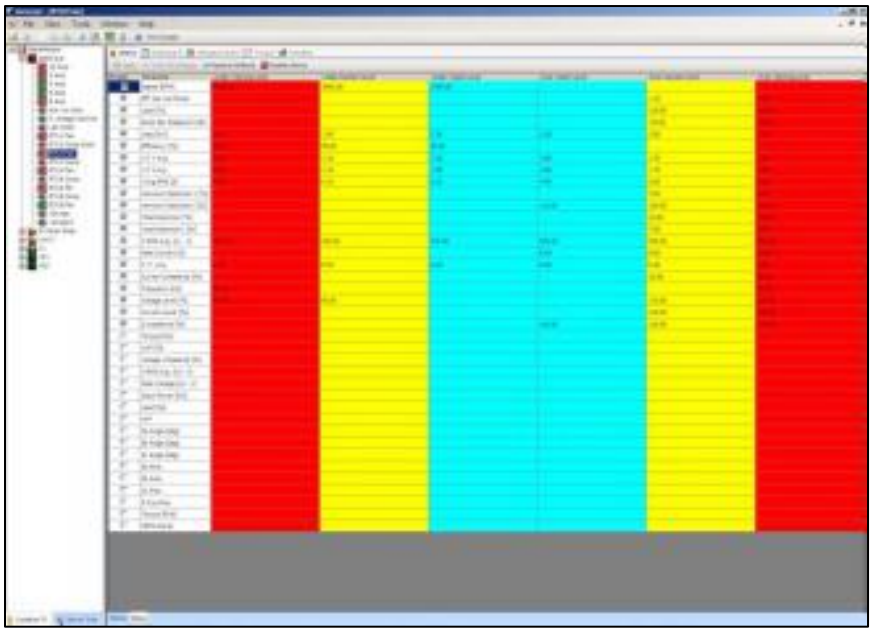


Fig 5-2: Alarm setup

Enabling alarms
Enabling an Alarm instructs the NetEP to compare the measured values of the motor parameters to the limits entered in the alarm setup screen. Check the box in the Enable column of the motor parameter. Only those motor parameters with the Enable box checked are shown on the alarm status screen.

All limit checking of motor parameters can to turned off (for this motor) by clicking the Disable Alarms button near the top of the alarm setup screen. Undo this action by clicking the **Undo All Changes** button.

Viewing alarm status
When an alarm level is reached, the NetEP sets an alarm for that parameter. If a watch level was reached, on the Alarm State tab, the Result, Click to Acknowledge, Last Value and Last Tested cells are all shaded based on the type of alarm limit reached; blue for a watch level, yellow for a caution level and red for a warning level. Similarly, in the motor selection pane, the motor, and any voltage buss, folders and databases above it will also be shaded with the appropriate alarm color.

To see the alarm status of all motors, click on the View menu item, choosing the Machine Status Grid. The data grid has two views, an icon per motor, or a colored rectangle per motor. The view can be changed by clicking the Toggle Views button near the top of the
screen. The Machine Status Grid view provides an at a glance, single screen showing the status of all motors. A color shading scheme is used: green for all parameters within limits, blue for watch limit exceeded, yellow for caution limit exceeded and red for warning limit exceeded. Summary information for the motor can be viewed by moving the cursor over the motor icon or square representing that motor. Double clicking on the rectangle or motor icon will display the alarm status tab for that motor.

Fig 5-3: Motor status grid – block view

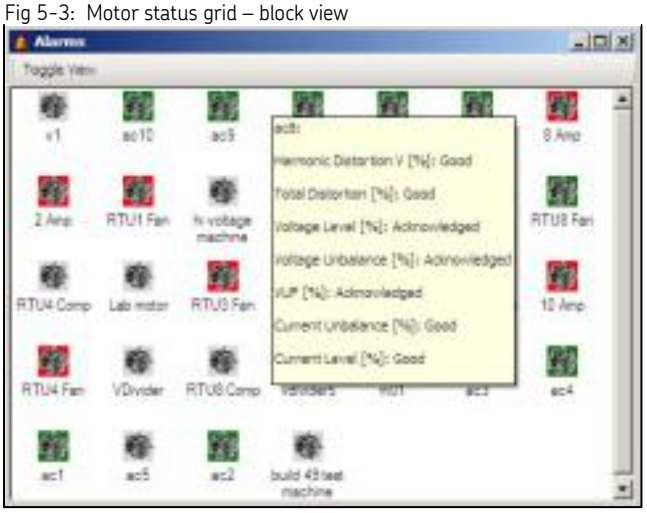


Fig 5-4: Motor status grid – Motor view

6
Dashboard

The Dashboard tab shows the most recent data for motor parameters in either a summary graphical (gauge) format, or in a detailed text format. The Dashboard is useful for understanding what is going on with a motor currently. It shows complete power quality, voltage, currents, distortion, components, power, and machine performance data. However, it does not present the spectrum data. To view spectrum data, navigate to the Voltage/Current tab for Voltage/Current spectrum information, or to the torque tab for torque spectrum information.

To open the dashboard view, open a motor window (double click on the motor icon in the location or server tree) and choose the Dashboard tab at the top of the motor window.

The default view shows the Voltage RMS level, level in percent (of nameplate), harmonic distortion, and voltage unbalance on the top row. The second row shows the current RMS level, level in precent (of nameplate), peak current and current unbalance. The third row shows the voltage frequency, power factor, component avg amplitude, and input power. The last row, machine guages, shows the motor speed, torque, load in precent of nameplate, and load in KW. The parameters shown in the guages will update as soon as new data is available. For parameters such as voltage level and current level, this will be several times per minute. For parameters such as speed, which require a time waveform acquisition, these will update approximately once per hour.

Each gauge displays the name of the parameter being shown immediately above the guage. The needle moves to show the value of the parameter on the guage, and a digital display of the value is shown beneath the guage. The needle position and the digital parameter value update each time new information is available.

The dashboard gauges can be reconfigured by right clicking on the gauge, then selecting the parameter for the guage to display. Only 16 gauges can be displayed at one time in the window. Even though the window is divided into a power gauges and machine guages, any motor parameter

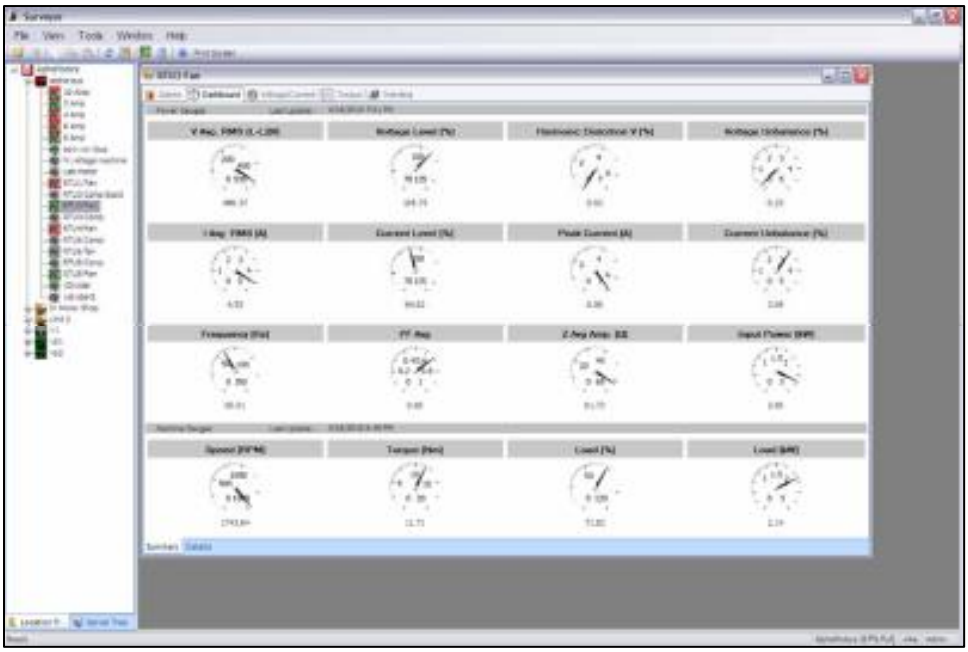


Fig 6-1: Dashboard

can be placed in either area.

The grey bars with the title of the gauge section in it also displays the time at which the displayed data was taken. Seeing that these times update periodically is an easy way to verify that the NetEP is gathering data properly.

There is no combination drop down box with time stamped results available for the dashboard. Dashboard shows the most recent data only. To select and view past data for the motor, use the trending tab.

To see a detailed textual view of the most recent motor data, select the Details tab at the bottom of the motor results window. This view is grouped by machine, power quality, power, voltage, current, distortion and components. Detailed information about each phase, as well as the average or sum is also presented in this details view of the dashboard. Like the gauges, these values update as soon as new information is available. The title for each group in this detail view includes the time at which the displayed data was taken.

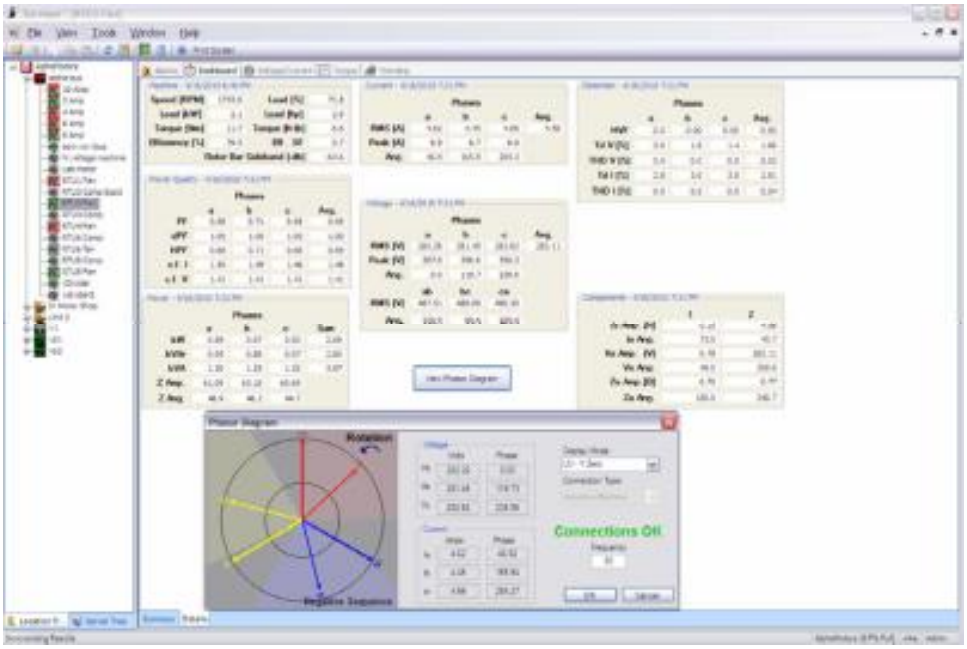


Fig 6-2: Dashboard text

Click the view phasor diagram to see the voltage and current phasors. This phasor diagram screen is a read only screen to review data only. No changes can be made here. Connection setup changes can only be done at the NetEP device using the configuration tool. The phasor diagram represents the sequence of the voltages and currents for this motor.

Note: This is a function of how the motor is wired to the grid, and also how the NetEP voltage inputs and CT inputs are connected. The phasor length represents its amplitude, and its angle position represents its phase angle relative to Va (which is defined as the reference and thus has an angle of 0). The phasor arrows are color coded to group phase voltages and currents together. Phase A is red, phase B is blue, and phase C is yellow.

A positive sequence is defined as an A B C sequence, and a negative sequence as an A C B sequence. See the NetEP data definition section for more information on understanding and using phasors and components for motor monitoring.

Note also that the components definition in the NetEP assumes a positive sequence. Thus, V1 amplitude is the positive sequence voltage component if the phasor rotation is positive. If the phasor rotation is negative, V1 amplitude represents the negative sequence voltage component.

On the phasor diagram, the view of the phasor is selectable. The four choices are:

LN – Y zero
LN – X zero
LN & LL - Y zero
LN & LL - X zero

These choices refer to line to neutral (LN) or line to line (LL) to determine phasor amplitudes, and where the Va phase (always 0) will be shown, on the Y axis (Y-zero) or on the X axis (X-zero). Thus, to see the phasors, both line to line and line to neutral with the Va phase on the X axis, choose the LN & LL X-zero option.

7
Voltage/Current

The voltage/current tab is where the time waveform data, spectrum and harmonics for voltages and currents can be viewed. **Note**: To view this data, a time waveform acquisition for this motor must have been acquired. By default, the NetEP performs a time waveform acquisition approximately once an hour, for every motor.

Unlike the dashboard and trending tabs which show the values of many motor parameters, the voltage/current tab shows the actual waveforms of the voltages and currents captured by the NetEP for a specific motor. This is shown as time waveforms – that is, as they would be seen on an oscilloscope, and also as a spectrum and a harmonics bar chart. The spectrum and harmonics charts are useful for detecting and diagnosing faults that show up as specific frequencies in the motor, for example, rotor bar faults.

The time waveform display is a quick way to look at the voltage and current and be sure that nothing major is wrong. For example, an entire phase has been disconnected. It's also a quick way to verify that the motor is indeed on and drawing expected currents.

Time waveform plots

1) Select the voltage/current tab in the motor results window.

2) On the left hand side of the results window, select the voltages and currents to plot. By default, all voltages and currents are displayed. The voltages are displayed using thick lines, while currents are displayed using thin lines. The phases are color coded, phase A is red, phase B is blue and phase C is yellow.

3) Use the trigger and slope drop down boxes to control how the display at time zero is shown. For example, to see phase B current as it crosses zero amps as the starting point for the graph, select Ib in the trigger box, and falling in the slope box.

4) Select the date and time for the results to display from the drop down box.

5) To scroll through the different date time results, use the left and right arrows on the blue background next to the date time selection box.

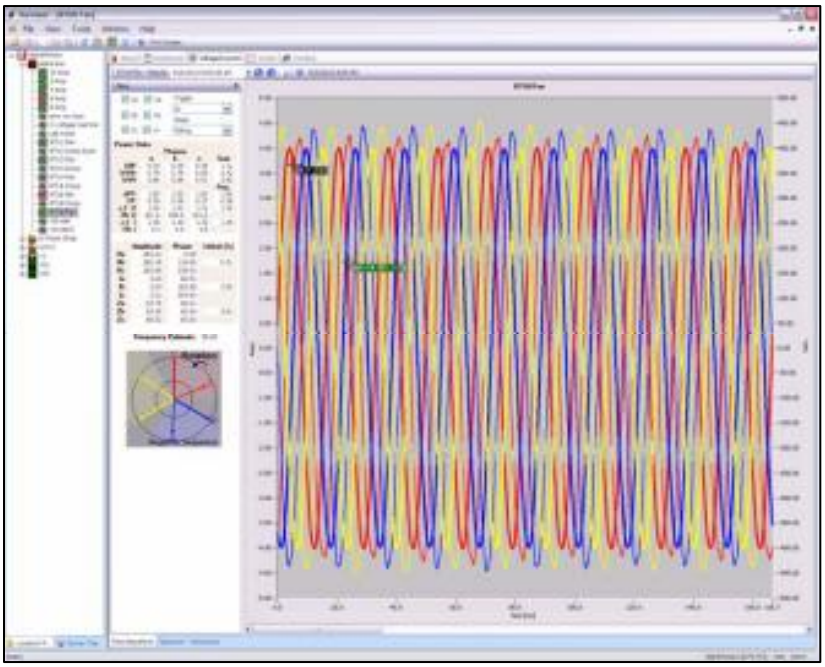


Fig 7-1: Voltage/current screen

6) The power data, voltage, current, symmetrical component data and phasor diagram are also displayed for reference here.

7) The scroll bar at the bottom of the waveform display can be used to scroll through zoomed X-axis data.

8) Help for controlling the zoom of the display is available by clicking the small ? symbol at the top of the time waveform screen.

9) Zoom: Click the mouse and drag the cursor to define the area to which to zoom in on. As the cursor is dragged, a dotted line appears showing the area that will be displayed when the mouse button is released.

10) Zoom X-axis only: Click the left mouse button and drag the cursor straight parallel to the X-axis. The dotted lines showing the new display area will shift to vertical lines showing the portion of the X-axis that will be zoomed to.

11) Zoom Y-axis only: Click the left mouse button and drag the cursor straight parallel to the Y-axis. The dotted lines showing the new display area will shift to horizontal lines showing the portion of the Y-axis that will be zoomed to.

12) Cancel zoom: with the left mouse button still depressed, hit the escape key.

13) Undo zoom: press the spacebar.

14) Reset from Zoom: Press the Control and Spacebar keys simultaneously

Spectrum Plots

1) Select the Spectrum tab from the lower left hand corner of the motor results window to view the spectrum

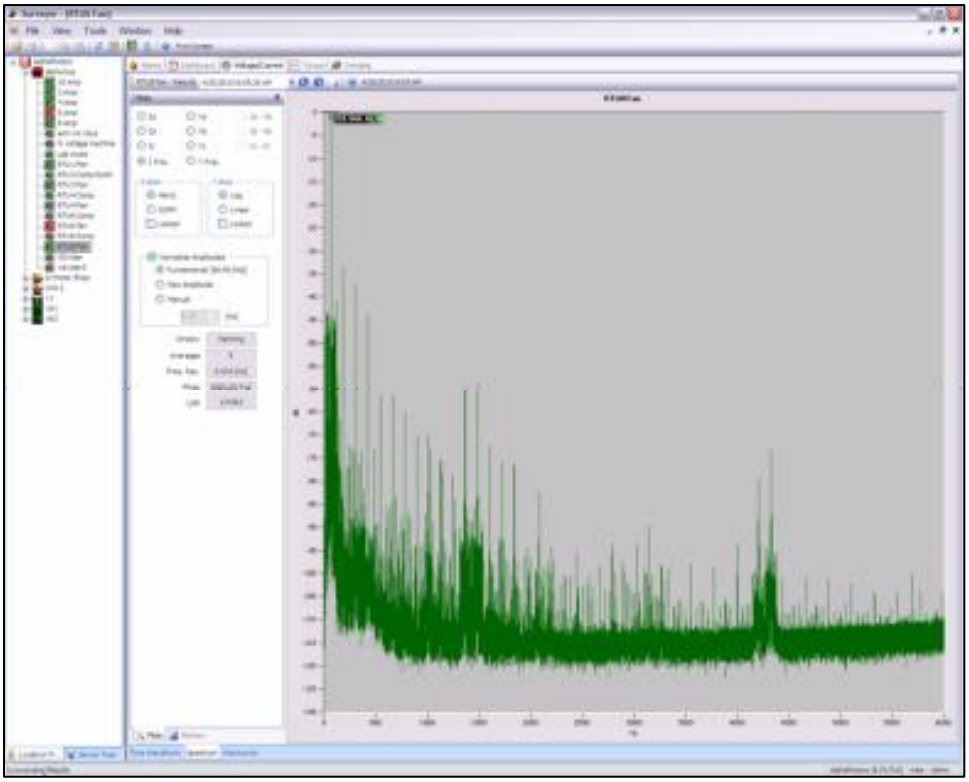


Fig 7-2: Voltage/current spectrum plot

2) The spectrum display shows the frequency components of a signal. Spectrum plots are useful for looking for and diagnosing motor problems that have a specific frequency associated with them. For example, rotor bar faults. As a rotor with a broken rotor bar rotates in the stator, it creates a disturbance in the currents being drawn by the motor at a specific frequency. The NetEP calculates this frequency. Using current spectrum, that particular frequency can be displayed and evaluated for a rotor bar fault. The height of the line at any frequency represents the amplitude of the signal at that frequency. Since in an electrical system, currents are carried in addition to the line frequency current, the line frequency will typically be the highest peak. However, this peak will vary with each motor type and its load. To make comparison of frequency peaks easier, spectrum plots are typically normalized to the height of the line frequency peak. This allows the comparison of other frequency amplitudes to the amplitude of the fundamental as a ratio, thus allowing comparisons between motors. For example, the amplitude of the rotor bar frequency for a motor drawing 1000 A might be 5.6 A, while a motor drawing 300 A might have the amplitude of the rotor bar frequency of only 1.6 A. Yet, relative to the line frequency amplitude, the ratio of the amplitude of the rotor bar frequency is the same, -45 dB. Spectrums can be displayed either in log or linear form. Using the log scale allows much lower signal levels to be seen. Every 20 dB in the log display represents a factor of 10 in a linear display. That is, a signal frequency that is 20 dB smaller than another signal frequency is $1/10^{th}$ the amplitude of the larger signal. Thus a signal that is 60 dB smaller (smaller signals have a minus sign on the dB value, where larger signals have a positive dB value), that is -60 dB is $1/1000^{th}$ the size of the signal it is being compared to. Note that with the NetEP, signals as small

as -100 dB, or 1/10,000th of the fundamental amplitude are visible. Using a linear scale, a signal that was 1/10,000th just disappears as it is so small relative to the fundamental signal amplitude. For this reason, spectrum analysis and motor diagnostics using the spectrum are usually done in dB.

3) Similar to the time waveform, select the voltages or currents to display in the upper left hand corner of the motor results window. **Note**: The average voltage, current and the difference of voltage and current is available. These differences are useful in distinguishing between frequencies coming from the power source (voltage spectrum), and those frequencies resulting from the action of the machine (found in the current spectrum).

4) The Y-axis of the spectrum display can be shifted between a log and a linear scale. Check the Locked check box to keep the Y axis scale fixed. Using a log Y axis scale allows a greater dynamic range of signals to be viewed.

5) The X-axis can similarly be changed between a hertz or a KCPM scale, and can likewise be locked via the Locked check box.

6) The window, averages, frequency resolution and maximum frequency (FMAX) are all read only values displayed here for reference only.

7) The graph can be normalized in a number of ways, the system determined fundamental frequency, the highest amplitude frequency, or by manually entering the frequency whose amplitude the graph will be normalized to. In most cases, using the system determined fundamental frequency will yield the best results.

8) Redrawing of the spectrum can be done automatically as changes are made (to scales or components to plot) if the automatically redraw checkbox is selected, or via the redraw graph button if the checkbox is not selected.

Markers

1) To assist in identifying frequencies of interest in a spectrum display, markers are available. In the lower portion of the plots area, click on the markers tab.

2) Select the frequency to mark in the spectrum using the check boxes at the top of the marker area. Multiple frequencies of interest can be marked at the same time. This list consists of the NetEP generated rotor bar, fundamental and speed frequencies, along with the bearing frequencies defined in the motor properties/machine parts dialog.

3) The marker on the spectrum plot is labeled with the frequency name, and the frequency that is marked. The color of the markers associated with a frequency can be changed by clicking on the marker color box (the box is filled with the present color selected for that marker), and then selecting a new color from the pop up palette of colors.

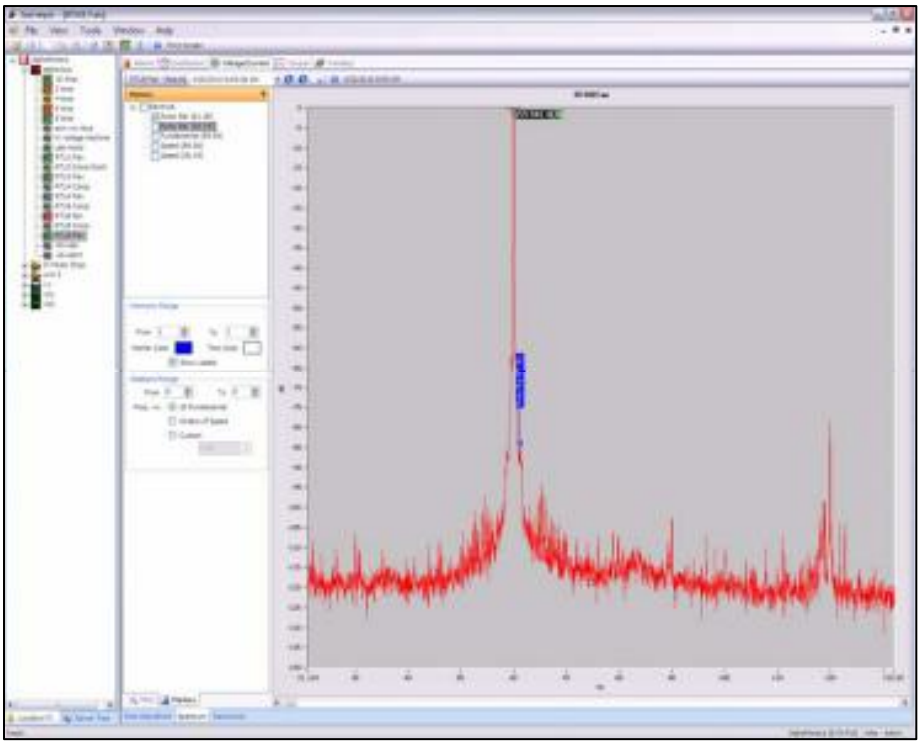


Fig 7-3: Voltage/current markers

Harmonics of the frequency of interest can be displayed by selecting the number of harmonics to display in the harmonics range: to box.

Harmonics

1) Select the harmonics tab from the lower left hand corner of the motor results window to view the spectrum harmonics.

2) Select the date and time for the results to display from the drop down box.

3) To scroll through the different date time results, use the left and right arrows on the blue background next to the date time selection box.

4) The harmonics display shows the harmonics of the system determined fundamental frequency for the voltage and current components selected.

5) For reference, harmonic distortion, total distortion and the harmonic voltage factor and harmonic power factor are displayed.

6) Harmonics (distortion) measurements quantify how different a signal is compared to a perfect sine wave. AC rotating machinery works best when powered by a pure sine wave. Any power that is delivered to a motor that is not a sine wave does not do any work and ends up as heat. Therefore, the lower the levels of distortion the better.

7) Distortion can arise from several different sources. For example, upstream transformers can be saturating and warping the sine wave. VFD's can impress all types of noise on a voltage bus.

8) Total distortion (Td) is a ratio of the amount of a signal that is not in the fundamental frequency to the fundamental signal (either 50 Hz or 60 Hz). Therefore, the Td is a ratio of everything but the fundamental to the fundamental.

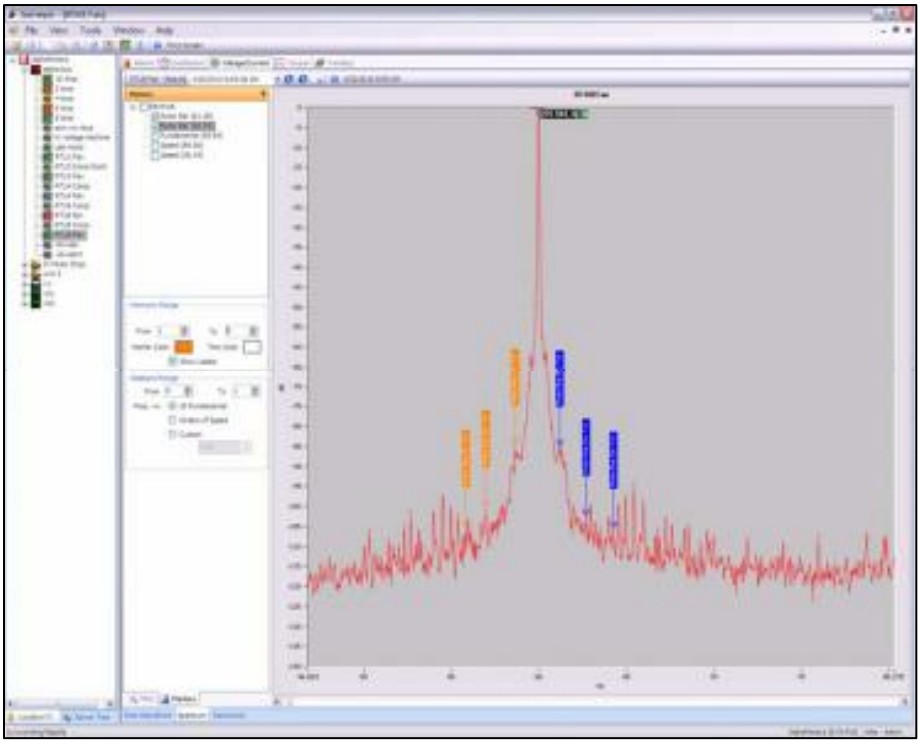
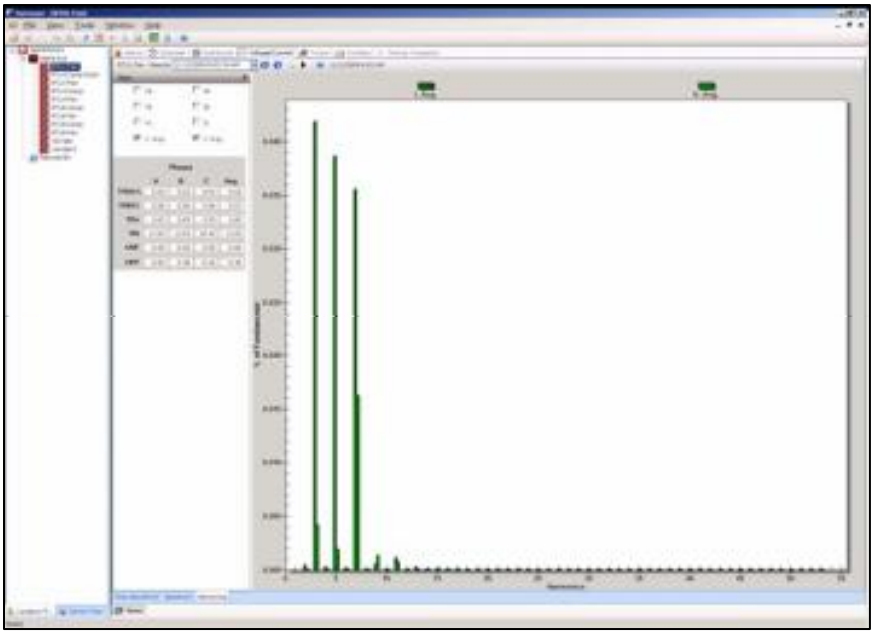


Fig 7-4: Voltage/Current markers zoom in

9) Total harmonic distortion (THD) is a ratio of the harmonics of the fundamental to the fundamental itself. Harmonics of 60 Hz are 120 Hz, 180 Hz, 240 Hz, etc. THD is very different from total distortion (Td), because Td will sum up all the frequencies in a signal and compare the sum to the fundamental, while the THD will just sum up the harmonic frequencies and compare the sum to the fundamental

Fig 7-5: Voltage/current harmonics



8
Torque

The torque tab in the motor results screen is where both torque versus time and torque spectrum data is found. Navigate to the torque screen by double clicking on the motor of interest in the motor selection pane, then selecting the torque tab in the motor results screen.

To view torque data, a time waveform acquisition must have run on the motor.

Unlike the voltage/current view, the torque delivered by the motor is generally not dominated by the line frequency component. This simplifies the analysis of the motor performance, since the frequencies of interest are not modulated with the line frequency, and their amplitudes are generally higher than in the voltage/current view.

See the chapter on NetEP data definitions and use for more information about how to use the torque data.

Torque time waveform (torque vs time)

1) Select the date and time for the results to display from the drop down box.

2) To scroll through the different date time results, use the left and right arrows on the blue background next to the date time selection box.

3) For reference, the nameplate rated torque is also drawn on the graph.

4) Like the voltage/current time waveform display, the torque time waveform can be zoomed and scrolled.

5) Zoom: Click the mouse and drag the cursor to define the area to which to zoom in on. As you drag the cursor, a dotted line appears showing the area that will be displayed when the mouse button is released.

6) Zoom X-axis only: Click the left mouse button and drag the cursor straight parallel to the X-axis. The dotted lines showing the new display area will shift to vertical lines showing the portion of the X-axis that will be zoomed to.

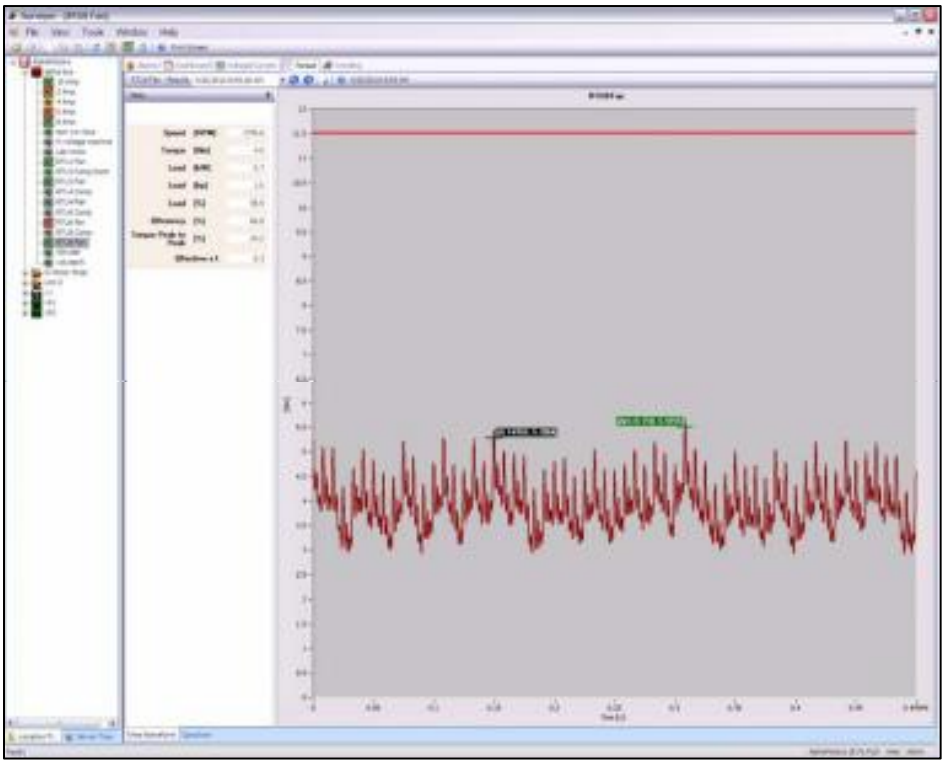
7) Zoom Y-axis only: Click the left mouse button and drag the cursor straight parallel to the Y-axis. The dotted lines showing the new display area will shift to horizontal lines showing the portion of the Y-axis that will be zoomed to.

8) Cancel zoom: with the left mouse button still depressed, hit the escape key.

9) Undo zoom: press the spacebar.

10) Reset from zoom: Press the control and spacebar keys simultaneously.

11) The delta cursor displays the difference in time between the two cursor locations and the amplitude of the delta cursor. Both cursors can be dragged and dropped to other locations on the waveform.



12)

Fig 8-1: Torque

Torque Spectrum

1) Like the voltage/current spectrum, the torque spectrum shows all the frequencies that make up the torque delivered by the motor. Having each frequency visible in a spectrum plot allows quick identification of frequencies that may show a motor/machine problem. The height of the line at any frequency represents the amplitude of the signal at that frequency. Spectrums can be displayed either in log or linear form. Using the log scale allows much lower signal levels to be seen. Every 20 dB in the log display represents a factor of 10 in a linear display. That is, a signal frequency that is 20 dB smaller than another signal frequency is $1/10^{th}$ the amplitude of the larger signal. Thus a signal that is 60 dB smaller (smaller signals have a minus sign on the dB value, where larger signals have a positive dB value), that is -60 dB is $1/1000^{th}$ the size of the signal it is being compared to. Note that with the NetEP, signals as small as -100 dB, or $1/10{,}000^{th}$ of the fundamental amplitude are visible. Using a linear scale, a signal that was $1/10{,}000^{th}$ just disappears as it is so small relative to the fundamental signal amplitude. For this reason, spectrum analysis and motor diagnostics using the spectrum are usually done in dB.

2) At the lower left corner of the motor results window, select the spectrum tab.

3) The Y-axis of the spectrum display can be shifted between a log and a linear scale. Check the locked check box to keep the Y-axis scale fixed. Using a log Y-axis scale allows a greater dynamic range of signals to be viewed.

4) The X-axis can similarly be changed between a hertz or a KCPM scale, and can likewise be locked via the locked check box.

5) The window, averages, frequency resolution and maximum frequency (FMAX) are all read only values displayed here for reference only. These values were set as part of the scheduled time waveform acquisition in the scheduler tab for this motor.

6) The graph can be normalized in a number of ways, the system determined fundamental frequency, the highest amplitude frequency, or by manually entering the frequency whose amplitude the graph will be normalized to. In most cases, using the system determined fundamental frequency will yield the best results.

7) Redrawing of the spectrum can be done automatically as changes are made (to scales or components to plot) if the automatically redraw checkbox is selected, or via the redraw graph button if the checkbox is not selected.

Markers

1) To assist in identifying frequencies of interest in a spectrum display, markers are available. In the lower portion of the plots area, click on the markers tab.

2) Select the frequency to mark in the spectrum using the check boxes at the top of the marker area. Multiple frequencies of interest can be marked at the same time. This list consists of the NetEP generated rotor bar, and speed frequencies, along with the bearing frequencies defined in the motor properties/machine parts dialog.

3) The marker on the spectrum plot is labeled with the frequency name, and the frequency that is marked. The color of the markers associated with a frequency can be changed by clicking on the marker color box (the box is filled with the present color selected for that marker), and then selecting a new color from the pop up palette of colors.

9
Trending

Trending is where the motor's parameters are examined and how these parameters change over time. This can be useful for identifying early warning signs of trouble, before a motor failure occurs. The trending display also shows how motors perform over the course of a day, or other time period.

The trending tab provides both a graphical view of the data, as well as a grid view of actual values over time. This data can be exported in a CSV format for additional analysis or graphing.

To get to the trending screen, double click the motor to examine in the location pane, then click the trending tab at the top of the page. On the trending screen, in the lower left hand corner, either select the grid or graph view.

Grid View

1) Allows the simultaneous viewing of multiple parameters over time.

2) Displays data in a textual, grid format.

3) Double click the parameter name at the top of each column to sort the entire table by that column. An arrow appears indicating if the column is sorted in ascending or descending order. To change from ascending to descending or vise versa, click the column name again.

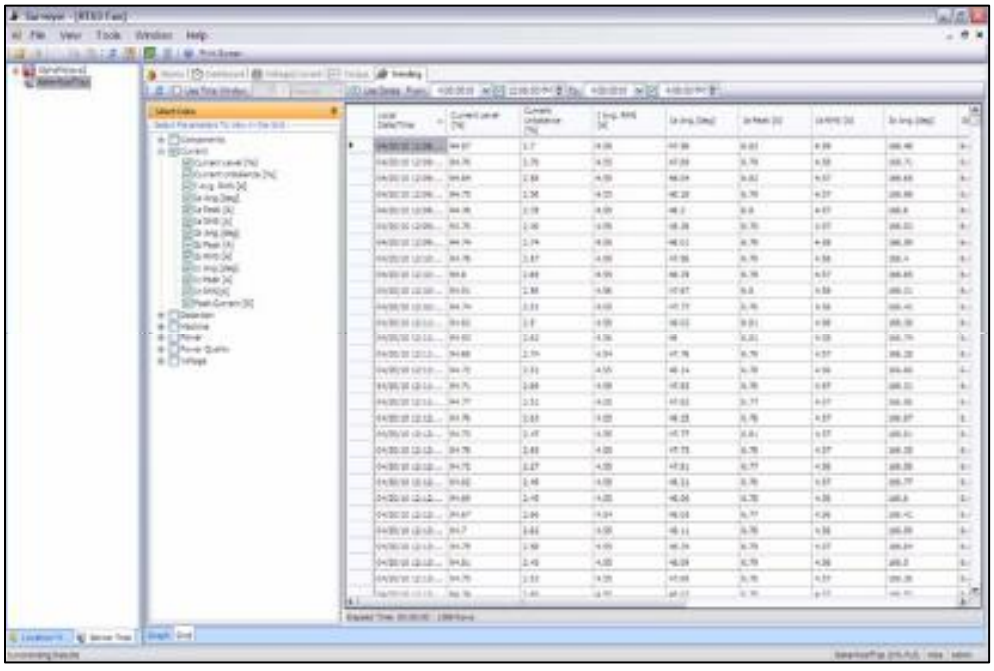


Fig 9-1: Grid view

4) To the left, the select data area is where the parameters are selected. Parameters are grouped for easier navigation. By checking the group name, all the parameters in that group are selected and displayed. In the example above, all the current data is selected for viewing.

5) Beneath the parameter selection area, is a time selection area. This allows the selection of data only from certain periods. This can be either a specific date and time – using the from\to dates or a time window. The time window shows the most recent data in the window selected. In the example above, the period from 4/20 at 12:08 PM to 4/20 at 4:08 PM is displayed.

6) Note that each parameter result has a time stamp associated with it. This makes it easier to investigate events at specific times.

7) To update the grid with data gathered since the trending window was initially opened, click the refresh grid button in the center of the select data pane.

8) Data from the grid view may by exported in a CSV format by right clicking in the grid area. Enter a filename and location to save the CSV file.

Graph view

1) Use the graph view to see a plot of a parameters value over time.

2) To the left, the plots area is where the parameters you want to see are selected. Parameters are grouped for easier navigation. Only one parameter can be selected for viewing at a time. To select a parameter, double click it.

3) Beneath the parameter selection area, is a time selection area. This allows the selecting of data only from certain periods. This can be either a specific date and time – using the from\to dates or a time window. The time window shows the most recent data in the window selected. In the example below, data from April 20 at 12:08 PM to April 20 at 4:08 PM is displayed.

4) To change the parameter graphed, simply double click on the parameter name in the plots parameter pane.

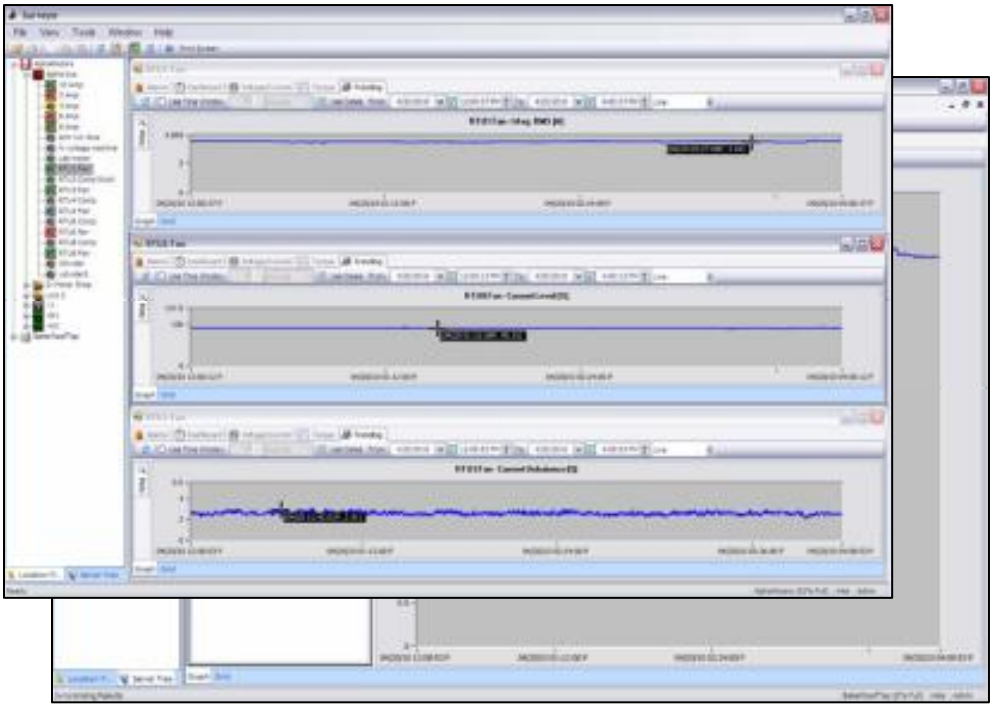
5) To update a time window graph, double click on the parameter name again.

6) To change the period displayed, enter new values into the from and to date and time fields. When done, click the refresh button at the far left of the trending tool bar.

7) To see a moving window, over time, select the use time window box. This display always has now at the end of the X-axis. The data will literally scroll across the display, showing a display similar to a strip chart for the parameter selected. This is particularly useful for monitoring values, which may be changing frequently or periodically.

8) Trending graphs acan be shown with lines connecting the actual data points, or as individual points. Use the line or point pull down to select how the graph will plot. Point view is useful to understand if a transient event (for example a current spike) was a sustained or single event. Using the point view, with one dot per data point

acquired, it is very easy to tell if the event was present for multiple readings or just a



single reading.

9) The trending graph does not support zooming capability when in the use time

Fig 9-2: Trending graph

window mode. The trending graph does support the zoom capabilities when in the use dates mode.

Multiple Windows

1) Like all other NetEP windows, the trending windows can be minimized to display multiple windows, and therefore multiple motors or multiple parameter graphs, at the same time. To do this, click the restore down button in the upper right hand corner of the trending window.

2) This makes the window smaller than the entire results screen area.

3) Select another motor and parameter to trend, and set up the trending time period. Click the restore down button on this window.

4) On the NetEP toolbar, click the window menu item, and select tile horizontal to line up the trending windows beneath each other.

5) To see more data, the parameter selection pane can be hidden by clicking on the pin icon in the upper right hand corner of the parameter selection pane. To get the panel back, click on the select data box, then click the pin icon to keep the select data area displayed. An example multiple window trending display is shown below.

Fig 9-3: Trending graph, multiple windows

Appendix A
Installing MS SQL Server or MS SQL Express 2005, 2008 (reference only)

Installing SQL Server or SQL Express 2005

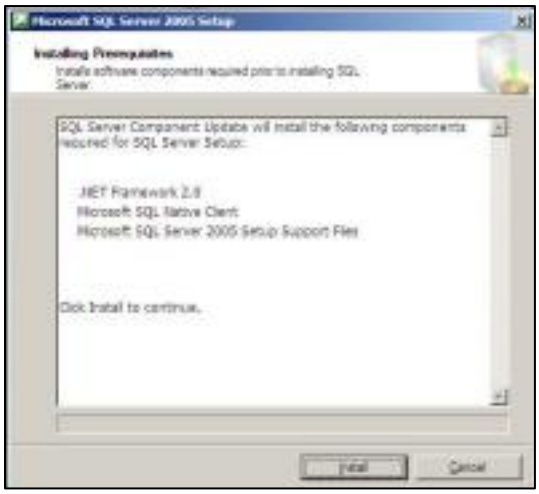
Either Microsoft SQL Server 2005 or Microsoft SQL Express 2005 is required for the NetEP or iNetEP server software to operate correctly. Purchase SQL Server from Microsoft, or download SQL Express from Microsoft. While SQL Express costs less than SQL Server, it is limited to a 4GB database size.

Note: *This installation process is for reference only. When possible, use the most current Microsoft installation process. The installation process may vary depending on version.*

1) On the End User License Agreement window, read the license agreement, and then select the check box to accept the licensing terms and conditions. Accepting the license agreement activates the **Next** button. To continue select **Next.**

Fig A-1: Microsoft SQL Server installing prerequisites

2) The system will then verify the necessary components required for install. To begin


Microsoft SQL Server 2005 Setup
Installing Prerequisites
Install software components required prior to installing SQL Server
SQL Server Component Update will install the following components required for SQL Server Setup:
.NET Framework 2.0
Microsoft SQL Native Client
Microsoft SQL Server 2005 Setup Support Files
Click Install to continue.
Install
Cancel

the component install process select **Install**.

3) After all prerequisite installs are complete, select **Next**.

4) On the welcome page of the installation wizard, select **Next** to proceed.

Microsoft SQL Server 2005 Setup
Installing Prerequisites
SQL Server Component Update will install the following components required for SQL Server Setup:
.NET Framework 2.0
Microsoft SQL Native Client
Microsoft SQL Server 2005 Setup Support Files
The required components were installed successfully.

Fig A-2: Installing Prerequisites

5)
6) The System Configuration Check scans the installation computer for conditions that may interfere with setup. (If there are problems, select **Cancel**, resolve the problems and start again.)

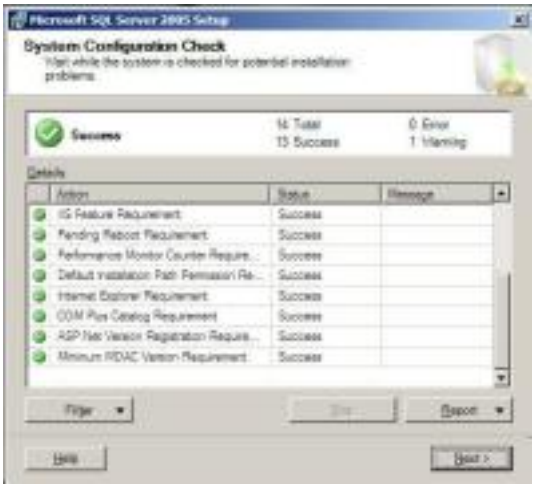
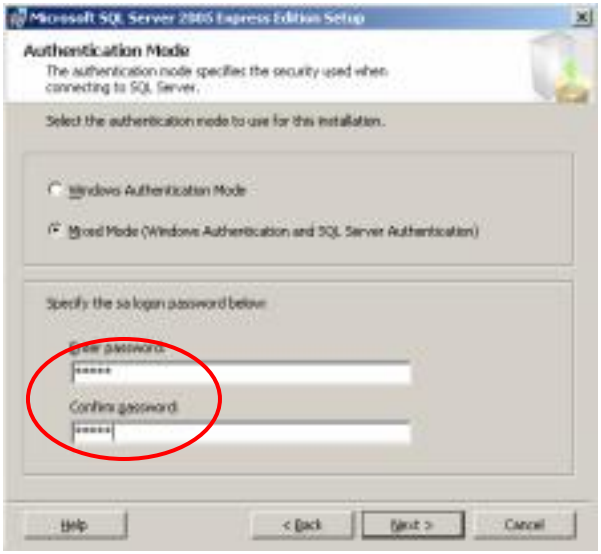


Fig A-3: System configuration check

7) To proceed with setup when the scan completes, select **Continue**.
8) On the Registration Information window, enter name and company name within the text boxes. To continue select **Next**.
9) On the Components to Install window, accept the default components installation configuration by selecting **Next**.
10) On the Instance Name window, select the radio button for Default instance. To continue, select **Next**.
11) On the Service account window, select **Next**.
12) On the Authentication Mode window, select **Mixed Mode** (as shown in Fig 3-4), and enter a password for the sa (system administrator) account.

Note: REMEMBER THIS PASSWORD!


Microsoft SQL Server 2005 Express Edition Setup
Authentication Mode
The authentication mode specifies the security used when connecting to SQL Server.
Select the authentication mode to use for this installation.
Windows Authentication Mode
Mixed Mode (Windows Authentication and SQL Server Authentication)
Specify the sa login password below
Enter password:
Confirm password:
Help
< Back
Next >
Cancel

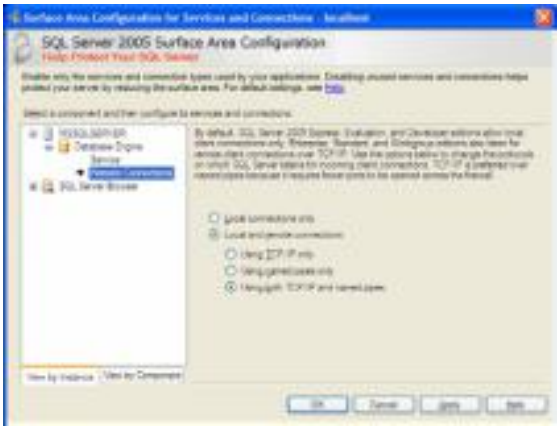
13) After the password has been acknowledged, select **Next** to proceed.

Fig A-4: Authentication mode

14) On the Collation Settings window, select **Next**.
15) Accept the default Report Server Installation Options by selecting **Next**.
16) On the Error and Usage Report Settings window, select **Next**.
17) On the Ready to Install page, review the summary of features and components. To proceed, select **Install**. Once installed, select **Next**.
18) On the Setup Progress page, monitor installation progress. When complete, select **Next**. (This may take several minutes.)
19) On the Completing Setup Installation Wizard page, select **Finish**.

Configuring SQL to allow remote connections

1) Go to Start – Programs – Microsoft Sql Server – Configuration Tools.



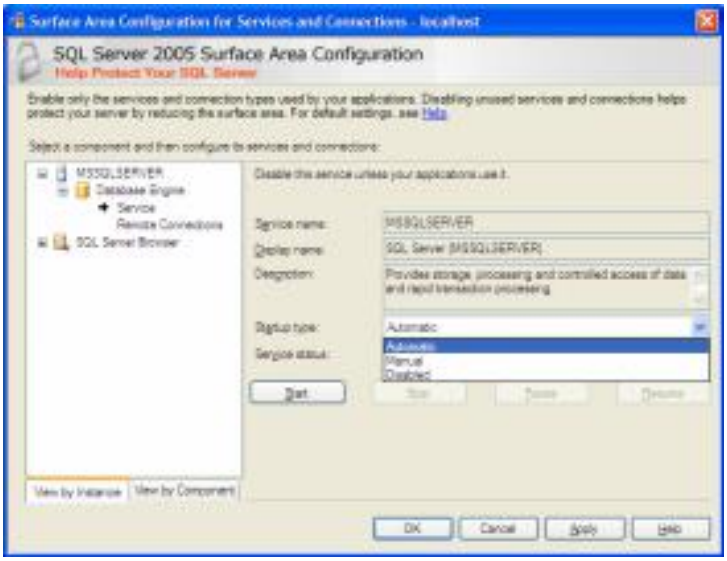
2) Launch the SQL Server Surface area configuration tool.
3) On the SQL Server Surface area configuration window, select **Surface Area Configuration for Service and Connections.**
4) Within the tree below the Database Engine, select **Remote Connections** as shown.
5) Enable the radio buttons for:
   - Local and Remote Connections
   - Using both TCP/IP and named pipes
6) To proceed, select **Apply**.

Fig A-5: Surface Area Configuration

7) Restart the Database Engine Service and the SQL Server Browser.

Restart Database Engine Server and SQL Service Browser

1) Go to Start – Programs-Microsoft SQL Server – Configuration Tools.
2) Launch the SQL Server Surface area configuration tool.
3) On the SQL Server Surface area configuration window, select **Surface Area Configuration for Service and Connections**.
4) Disable service by selecting **Stop**.
5) From the Startup Type drop down box, select **Automatic**.
6) Selecting **Apply** will activate the Start button. To proceed, select **Start**.



Installing SQL Server or SQL Express 2005

Installing SQL Express 2008

1) Download and run the Sql Express 2008 installer .
2) Click installation on the left side of the wizard.

3) Click new SQL Server stand-alone installation or add features to an existing installation. Click OK.
4) On the setup support rules page, click Next (the windows firewall warning is ok).

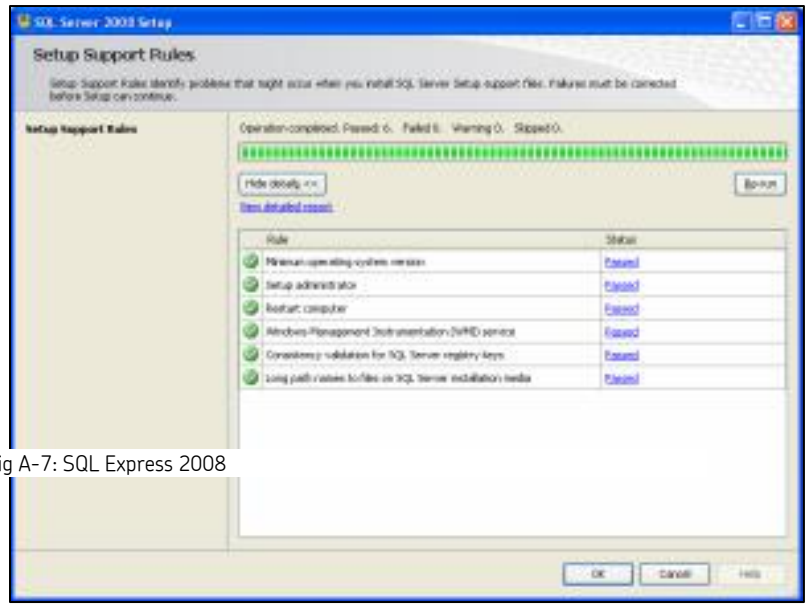


Fig A-7: SQL Express 2008

Fig A-8: Setup support rules

5) The product key screen is all grayed out with the specify free edition selected. Click next.

6) Read the license agreement and if you agree to the terms place a check in the checkbox, and click next

7) Other components my be required in order to run the installer. Click install to install these components.

8) Another rules wizard will determine if there are any problems in running the SQL setup files. Correct any failures and click next to continue.

9) Place a check next to **Database engine Services, Management Tools - Basic,** and any other features you would like install with your server and click next.

10) On the instance configuration, enter the instance name you would like to call your server, and the root directory. The instance name is used to connect to your server.

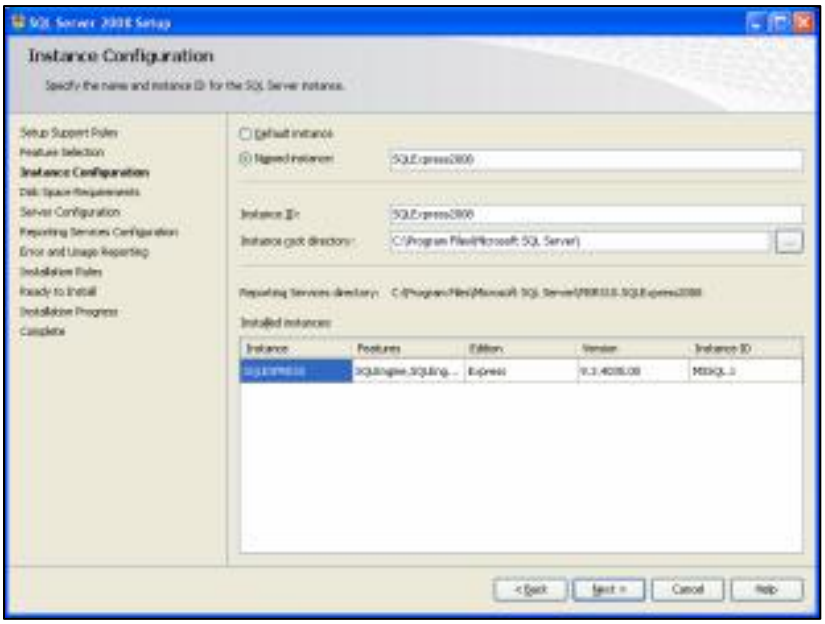


Fig A-9: Instance configuration

11) Click next on the disk space requirements screen.

12) On the Server Configuration dialog select NT AUTHORITY\NETWORK SERVICE for SQL server database engine and click next.

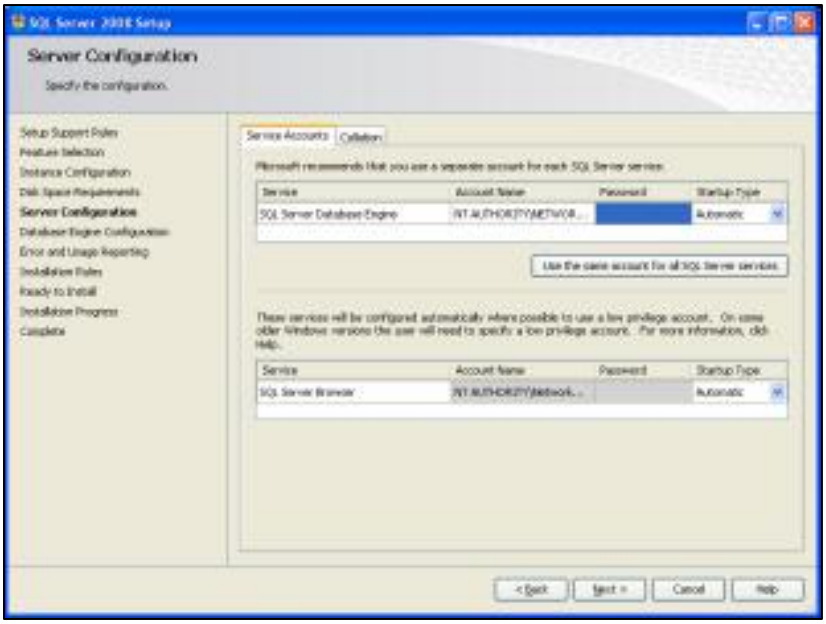


Fig A-10: Server configuration

13) On Database Configuration select "Mixed Mode" and enter a password for the system administrator (sa) account. Rememeber this password you will need it to access your server. Click Add Current User to create a Windows Administrator account.

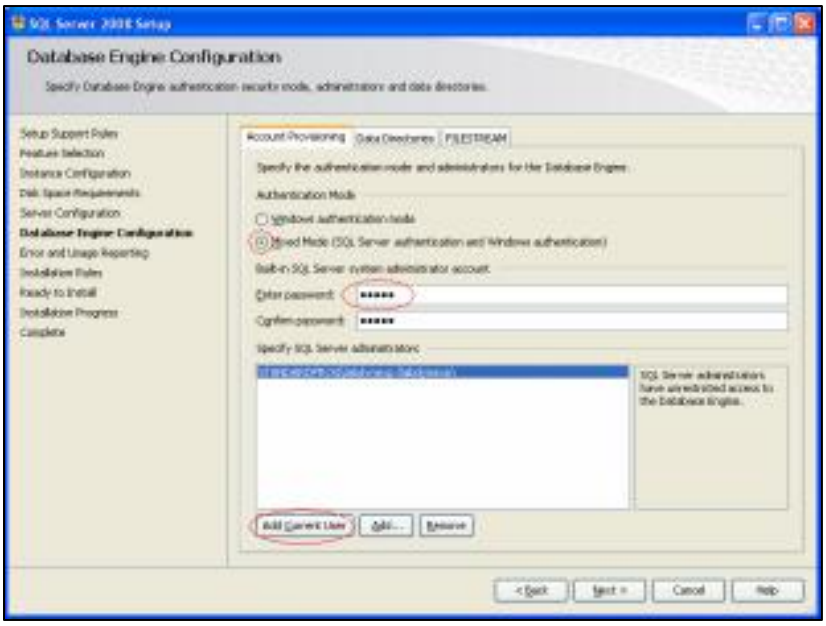


Fig A-11: Database engineer configuration

14) Click next on error usage and reporting.

15) Click next on Installation rules page if your system passed.

16) Verify that items listed to be installed are the items you want and click Install.

17) The installation process will begin. When it is complete verify that it installed correctly and click next .

18) Click close to exit the installation wizard.

Configuring SQL Sever to Allow Remote Connection (XP)

1) Go to Start->Program->Microsoft SQL Server 2008->Configuration Tools and launch SQL server configuration manager.

2) In the tree on the left pane click the plus next to SQL server network configuration, then select protocols for SQLEXPRESS2008 where SQLEXPRESS2008 is the instance name specified of the database engine during installation.

3) In the right pane right click on TCP/IP and then select enable.

4) Click ok on the message informing that there is a need to restart the services.

5) In the left pane select SQL server services.

6) In the right pane select SQL server right click and go to restart.

Configuring Windows firewall to allow remote connection (Windows XP x 86)

1) Right click on my network places and go to properties.

2) Right click on your network connection and go to properties.

3) Select the advanced tab.

4) Click the settings button to modify Windows firewall.

5) Click on the exceptions tab

6) Click on the add program button.

7) Click on the browse button and browse to the SQL server installation folder (C:\Program Files\Microsoft SQL Server)\MSSQL10.SQLEXPRESS\MSSQL\Binn) and select sqlservr.exe. then click open.

Appendix B
Technical specifications

Technical specifications and capabilities

- Continuously monitor 108 parameters on up to 32 motors on up to 7 voltage busses
- Peak, RMS, THD, TD, CF, unbalance, imbalance, power factor, input power and symmetrical components for each V, I phase, and in total.

Time Waveform acquisitions
- Spectrum acquisition (3 phases, voltage and current)
- Rotor bar sideband amplitude
- Time waveform acquisition
- Torque Time Waveform, torque spectrum, torque swing
- Speed
- Power out
- % Load
- % efficiency
- Effective Service Factor

Identify preventative maintenance opportunities
- Set alarms for parameter limits
- Display trends for parameters

Surveryor capabilities
- At a glance status for all machines connected to all NetEP, iNetEP
- Dashboard showing 105 measurements
- Time waveforms
- Voltage, Current, Torque Spectrums with frequency markers, harmonics, sidebands
- Torque time waveform
- Trending
- Add, delete, modify machines, alarms, voltage busses

Specifications

AC Input Power	110 V – 240 V, 50/60 Hz, 2.0 A
Current Transformers (CT)	5 A – 2000 A, up to 150 ft CT signal runs on Cat V cable, 18 K Hz signal acquisition
Voltage Busses	Up to 7 different voltage busses, up to 1000 V direct input or PT's, line-to-line, line-to-neutral, external disconnect required.

NetEP technical specifications

Environmental
- Size: 27.6 in x 19.7 in x 8.3 in
- Weight: NetEP: 56 lbs
- Enclosure: IP52, NEMA 12 (With Feedthru Plate Hole Plugs Installed)
- Operating Temperature: 0 °C to +50 °C Ambient
- Maximum Relative Humidity: 80% non-condensing
- Pollution Degree II

Standard Compliance
- Safety: UL 61010-1, EN 61010-1
- EMC: EN 61000-3/-2-3, EN 61000-4/-2-3-4-5-6-8-11, EN 61000-6/-2-4

NetEP Device Computer
- 1.0GHz Celeron or 1.4GHz Pentium EPIC SBC or Equivalent
- Memory: 2GB or Better
- Compact Flash: 4GB or Better

External Interfaces
- Ethernet RJ45, Video, USB

Ethernet Communication
- 10M/100M BaseT

NetEP Device Data Storage
- Storage Time Without Network Connection: Greater Than 1 Day - Typical (Depends on number of motors Scheduled)

Desktop Computer Requirements (Computer not provided by Baker/SKF)
- 5 GB Free Disc Space
- Windows XP, Vista or 7
- 1 GHz Pentimum Processor
- 256 Color Display
- 2 GB RAM
- 15” Display or Larger Recommended
- 10/100 LAN Connection

Server Requirements (Computer not provided by Baker/SKF)
- 2 GHz Pentium, Core2 Duo or Equivalent
- 2 GB RAM
- 10 GB Free Disc Space per NetEP Connected
- Windows XP, Vista, 7 or Server 2003
- 10/100 LAN Connection
- Microsoft SQL or SQL Express
- Static IP Address
- UPS Recommended

Voltage Bus Inputs
- 7 Three-Phase Voltage Bus Inputs
- 1000 VAC Maximum
- Measurement Category III
- Input Impedance: 2 MΩ per phase

- Amplitude Accuracy at 50/60Hz: ± 2% After Calibration
- Amplitude Resolution: 170mV
- Phase Accuracy at 50/60Hz: 0.4° Dwell, 1.0° Round-Robin
- External Disconnect Required

Current Transformer Inputs

- 32 Three-Phase AC Induction Machine CT Inputs (Voltage Output CTs)
- CT Options: 5A, 50A, 200A, 600A (Both Solid and Split-Core)
- Amplitude Accuracy at 50/60Hz: 2% (>1.0 A current level) after calibration

Phase Accuracy at 50/60Hz:

- 5A Solid Core CT: < 4° Variation from 10% to 100% Rated Current After Calibration - Typical
- 50A Solid Core CT: < 2° Variation from 10% to 100% Rated Current After Calibration - Typical
- 200A Solid Core CT: < 2° Variation from 10% to 100% Rated Current After Calibration - Typical
- 5A Split Core CT: < 2° Variation from 10% to 100% Rated Current After Calibration - Typical
- 50A Split Core CT: < 2° Variation from 10% to 100% Rated Current After Calibration - Typical
- 200A Split Core CT: < 2° Variation from 10% to 100% Rated Current After Calibration - Typical
- 600A Split Core CT: < 3.5° Variation from 10% to 60% of Rated Current After Calibration - Typical
  Frequency Response: 50Hz – 4000 Hz - Typical

Analog Measurement

- 16-bit ADC resolution
- 400 kS/s Aggregate Sampling Rate Maximum
- Frequency Range: DC to 6kHz

Calibration

- Recommended Interval: 12 Months
- Portable Calibration CTs Available

Analysis

- Time Waveforms
- Voltage, Current and Torque Spectra:
- Fmax to 6000Hz. Acquisition times from 30 to 120 seconds. Lines of resolution from 300 to 2.16M. Frequency resolution from 0.004Hz to 0.033Hz.
- Voltage Level - Per Phase and Average
- Voltage Phase Angle - Per Phase
- Voltage Unbalance
- Voltage Distortion
- Current Level, including Peak, and Phase Angle
- Current Phase Angle - Per Phase
- Current Unbalance
- Symmetrical Components
- Impedance Level and Angle
- Harmonics – Up to 100th
- Power - Real, Reactive and Apparent, Per Phase and Sum
- Power Factor - Displacement and Harmonic, Per Phase and Average
- Crest Factor - Voltage and Current, Per Phase and Average
- Fundamental Frequency
- Speed
- Efficiency*
- Torque - Instantaneous and Average (IEEE 1255-2000)*
- HP/kW*

- Percent Load*
- Effective service factor
- Rotor bar assessment

Features

- Round-robin
- Six alarm levels per parameter, up to 38 parameters per motor alarmed
- Data buffering in flash or hard drive when communication link is down: one day - typical
- Self-test capability

* Line-to-Line Stator Resistance (Hot) Required for Best Accuracy

Note: Information, specifications or capabilities published in this user manual are subject to change without notice.

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